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Developments in Systems of Compost-Making

It is evident that the making of good compost presents relatively small technical difficulties. The principles of the process are now well understood, and by following any one of the several published methods a planter should be able to make a satisfactory product. The real difficulty lies in the economic preparation of large quantities; that is, in the matter of costs; and the greatest factor of cost lies in transport.

In the original Indore system the compost was all made at a central site. This site could be chosen for an easily available water supply; but it was necessary to transport to it all the raw materials and later to transport the prepared compost back to the fields. The obvious development was to make the compost near to the source of the raw material and also near to the crop that was to receive the finished product—if necessary, on a multiplicity of sites. In our next issue we shall publish an article by Mr. Wolryche Whitmore describing his system for applying this principle on a farm growing annual crops, which themselves provide the greater part of the raw material. Meanwhile we now publish one by Mr. Tofte, in which the same principle is adapted to the needs of the permanent plantation.

It is often possible to plant areas with Napier grass or some other rapidly growing bulky plant, in close proximity to the permanent crops; and in the lay-out of new plantations a careful division of the land between these two should be a first

consideration. The cattle sheds and compost heaps can be sited near to both. But now a difficulty often arises in the supply of water. The old system requires large quantities of water, and if this has to be carried long distances, the cost may offset economies effected in the transport of other materials.

One way to overcome this difficulty is to rely on rain to wet the compost heaps, as described by Mr. Beckley in a recent paper (*East African Agricultural Journal*, Vol. II, pp. 384-386 and 470-473). But at best, where rainfall is ample, this makes composting a discontinuous process and complicates organization of labour. The essence of Mr. Tofte's method is to use the water naturally contained in fresh green vegetation, and so to make the compost without adding any water artificially to the heaps.

This is no new idea; but it has generally been supposed that the attempt to use unwilted green material would result in silage rather than compost. Mr. Tofte demonstrates, however, that compost can in practice be made. It seems likely that by his method the first stage is akin to ensilage; but that the high temperatures then developed kill the tissues and cause the release of the water held in them, so that after the first turn a normal aerobic fermentation sets in.

It is essential, if good compost is to be made, that during the later stages the conditions in the heap shall not prevent aerobic fermentation. We must suppose that, in spite of the trampling given after each turn, Mr. Tofte's heaps remain sufficiently open to allow air to enter. There is not, we suggest, any real conflict with this particular scientific principle of the Indore method. The practical development here described is, however, an important contribution to the problem of economic compost-making. H. H. S.

The Possible Effects of Copper Sprays on the Arabica Coffee Plant

The fungicidal action of copper sprays is believed to depend upon the formation of soluble copper in ionic form. This causes the death of the fungus, either directly or by its absorption into the host tissue, which thus becomes unsuitable for the establishment of the fungus.

With certain crops, including coffee, the application of a copper fungicide has a marked physiological effect, apart from the suppression of any known fungus. It is often considered economical to spray grape vines and potatoes for increased vigour and health only; and now one can add coffee, provided that other cultural practices have been carried out. Spraying the grape vine and potato with copper has been shown to bring about a greater formation of chlorophyll, with an increase in the thickness of the parenchyma and in the general activity of the tissues. The effect in coffee appears to be similar.

In the grape vine and potato assimilation and total transpiration are increased, although it is possible that transpiration is lessened during the heat of the day. In coffee it is probable that total assimilation is increased since in heavy bearing trees that have been sprayed there is less severe dieback due to carbohydrate deficiency. The limiting factor with heavy bearing coffee is usually carbohydrate and hence an increase of assimilation and increased vigour of the tree brought about by copper sprays plays an important part in the more economic production of coffee. In unfavourable seasons sprayed trees are better able to ripen a good crop of cherries, thus reducing the proportion of the remaining *buni* coffee.

Sprayed coffee trees also exhibit other symptoms. The leaves have a longer efficient life and abnormal heavy leaf fall is

reduced. Since Arabica coffee is favoured by a fairly low range of light intensity, it is possible that the greater opaqueness of the darker green leafage and the consequent mutual shading may be beneficial.

It has been shown that the physiological disease of "Tipburn" of potato is caused by the excessive loss of moisture under great heat, and that the disease can be lessened by an application of Bordeaux mixture. In this instance it is believed that the spray may retard transpiration or give a shading effect during the peak period; the transpiration curve may be raised, but it is made more smooth, thus eliminating the periods of high transpiration that bring about the scorching and death of parts of the leaf tissues. With coffee it is significant that a yellow or yellow-fringed unhealthy leaf will be more healthy in any part that is closely overlain by another coffee leaf, and there is usually more fringe-yellowing and scorching of the outside leaves on the warmer, more sunny side of the tree. Sprayed trees have fewer thin, yellow, unhealthy leaves with darkened tips, which suggests that the spray reduces the peak transpiration that causes tissue damage during the warmest part of the day.

Thus, briefly, it appears that, apart from any fungicidal effect, the results of the application of copper sprays to coffee include (1) greater formation of chlorophyll, (2) an increase in the thickness of the parenchyma tissues, (3) darker green leaves retained longer and less abnormal leaf fall, (4) increased assimilation, (5) increase in vigour and health of tree, which is thus better able to carry a heavy crop with less subsequent dieback, (6) reduction of damage to leaf tissues due to excessive heat and excessive transpiration.

In the main, the application of a copper spray should make for higher average yields and less biennial bearing in most plantations. More prolonged vegetative growth should be associated with slower fruit development and delayed, though more complete, ripening. Sprayed coffee trees give a greater out-turn of clean coffee, especially of the larger beans, per unit weight of cherry.

G. H. G. J.

Current Notes

Maize Resistant to Streak Disease

An officer of the Kenya Agricultural Department, who has recently visited the Empire Cotton Growing Corporation's Station at Barberton, South Africa, reports that success has been obtained there in breeding a maize variety resistant to streak disease. From a yellow-endosperm type, called Peruvian, pure lines have been bred showing apparently complete immunity under field conditions. Certain white-endosperm types have given lines with an enhanced resistance. The difference in growth of the resistant Peruvian and a susceptible type, under conditions of high infection, is very well marked.

Costs of Mechanical Cultivation

A pamphlet, giving the costs of cultivation with "Caterpillar" tractors, has come into our hands. These costs are based on prices and conditions ruling in Kenya, and have been arrived at after an extensive series of experiments. They will interest all farmers who are employing or contemplate employing mechanical traction. The pamphlet, entitled *Mechanical Cultivation by New and Improved Methods,* may be obtained from Messrs. Gailey and Roberts Limited, Nairobi.

Shaded and Unshaded Coffee

The Coffee Research Station, Lyamungu, has recorded over three years the yield of five hundred and thirty-one coffee trees of Bourbon type, planted in 1925 at 4,600 feet elevation about one mile west of Lyamungu. In different parts the plot contains three *Albizzia maranguensis,* which between them shade sixty of the recorded trees, at least from noon to 4 p.m. The rest of the coffee receives no shade between 10 a.m. and 4 p.m. The average annual yield from the shaded coffee is 1.9 lb. parchment, compared with 1.3 from the unshaded, the trees of which also show a higher individual variation. The results are suggestive.

A Useful Book

The practical man has often need of a handy reference book that can provide him with the facts and figures required in his work. Just as the engineer has had his "Molesworth", so, for more than fifty years, the farmer in Great Britain has had his McConnell's *Agricultural Note Book.* Recently, Prof. R. C. Wood, of the Imperial College of Tropical Agriculture, Trinidad, has stepped in to provide for a similar need of the farmer in the tropics. His *Note Book of Tropical Agriculture* has this year reached a second and revised edition. It contains sections on different aspects of estate engineering, agriculture, and animal husbandry, as well as a short one on statistics useful to the experimentalist. It is published by the Imperial College of Tropical Agriculture at 5/-.

Pasture

This year in the Trans Nzoia, cattle turned out to open veldt grazing did not pick up in condition as they are expected to, after the ploughing season. No doubt this is partly due to the effect of the unusually heavy rain on the low-lying pastures which became mere swamps in many cases. The continual leaching of soil nutrients under very wet conditions must also be a factor. In this connexion grass cutting experiments on natural veldt and Kikuyu plots have shown immediate and big increases from applications of sulphate of ammonia. Potash and phosphate plots have been no better, to date, than the control plots.

A Cheap Silo

Many farmers have expressed their dissatisfaction with the ordinary type of pit silo, entailing as it does considerable wastage at the edges and sides due to mixture of the material with soil. In addition water frequently seeps in at the sides of the pit and turns the material sour. It is for these reasons that some farmers have given up making silage, the value of which needs no emphasis, provided it is properly prepared.

Sisalkraft has been used for some time in the U.S.A. for lining small tower silos. Its use has now extended to Kenya and several silos made with it, including one at the Plant Breeding Station, Njoro, are now in operation.

Cedar posts 4 feet apart are planted in the ground in a circle and wired together with fencing wire, the strands being 2 feet apart. A space about 3 ft. 6 in. wide is left for the door, which is filled in with shuttering as the tower is filled up. Wattle or Mulelishwa (*Tarchonanthus camphoratus*) sticks are threaded between the wires. The silo is then ready for use. As the silo is filled sisalkraft is pegged on the inside with clothes pegs in layers, the pegs being removed as each layer is completed. When the whole is filled the roof may be thatched. If the tower exceeds 10 feet in height it may be necessary to wire the cedar posts together at the top so as to withstand the lateral pressure. The diameter of the silo can be made any convenient size, but if it is too great the silage may become mouldy when feeding, owing to its large surface.

A Simple Treatment for Loose Smut of Wheat

The Farmer's Weekly (South Africa) of 4-8-1937 draws attention to a discovery by Professor Jai Chand Luthra of a new method of treating wheat seed against loose smut, for which he has been awarded the Maynard-Ganga Ram prize. The normal hot water treatment involves steeping the seed in water that is maintained at a specific temperature, so that the spores of the fungus are killed whilst the germination of the seed is not impaired. The new method consists of soaking the seed in water at ordinary temperature for four hours. This should be done on a fine morning and the soaked seed should then be spread out in the sun until it is dry. It is said that this treatment is effective in controlling the disease without damaging the germinating power of the seed. Kenya wheat crops often have a slight infection of this smut, though any severe damage has yet to be recorded. The simplicity of the above method may, however, be of interest to growers.

White Blight in Maize

In the Trans Nzoia district of Kenya the heavy rain during the early growing period gave maize crops an irregular appearance and also increased the incidence of "White Blight" so that the leaves dried off prematurely with the advent of the dry weather. At the Kitale Experiment Station the general crop had about 100 per cent of the plants with varying degrees of "White Blight", whereas many of the pure lines in the maize breeding plot have stood up extremely well and shown little or no infection.

Tung Oil

In a cultural experiment with *Aleurites fordii* planted at Kitale this year the trees in large holes filled with top soil alone, or with cattle manure added, are looking better and are a deeper green than trees planted on merely well-ploughed land. In transplanting from the nursery all the trees were cut back and after three months every one of the 250 trees is growing well.

Granadillas

Attempts to establish the crop from various types of cutting have not been successful at Kitale. Cuttings of mature wood and young wood were equally abortive, but some hope is entertained that terminal cuttings may be more successful. There are, so far, no apparent differential effects from applications of various artificial fertilizers to the roots of one-year-old vines.

Diet and Disease

Nowadays the importance of good nutrition to man and his domestic animals is being particularly and rightly stressed. Obviously optimal well-being can only be achieved when every need of the body is fully satisfied. Numerous and formidable are the diseases directly due to deficiency of some essential mineral or vitamin, or to general under-nourishment; we need think only of lamsiekte, common in parts of South Africa; rickets; scurvy; or the miserable state of many stock, European-owned as well at native-owned, at the end of a long dry season.

But let us not think that if we and our stock are well fed we shall thereby escape most ills of the flesh. It is an unfortunate fact that the germs of many specific diseases flourish best, at any rate for a time, in well-nourished tissues, where they also provoke more intense reaction than could be aroused in debilitated tissues. As Dr. H. Warren Crowe, in a recent discussion of the subject (Proc. Roy. Soc. Med. XXX, 9, 1039) said: "The young strong healthy soldiers who died so rapidly and in such large numbers in the great influenza epidemic of 1918 were drowned in their own secretions owing to the intensity of their reactions."

It has long been accepted that strong, well-grown young cattle are more susceptible to the bacterial diseases of blackleg and anthrax than lean cattle. Recently, in Tanganyika Territory, French and Hornby have shown that good feeding did nothing to protect animals from acute trypanosomiasis. Now, the eminent veterinarian, Dr. J. T. Edwards, has brought forward the most striking example yet revealed of the deleterious effect that good nourishment may exert on the course of a specific disease. It is published in the Fifth Progress Report of the Foot-and-Mouth Disease Research Committee, and is quite conclusive. In rats, guinea-pigs and hedgehogs, the result was the same. Badly nourished animals were both more difficult to infect and reacted more mildly to inoculation than well nourished controls. Experimental work to determine the relation between state of nutrition and susceptibility to foot-and-mouth disease infection has not yet been carried out upon large domestic animals, but now that attention has been drawn to the matter, many stockowners in East Africa will recollect instances where the disease caused loss of condition or even deaths of high-grade, and therefore well fed stock, while native cattle getting no extra feed appeared to escape infection altogether.

There is, however, another side to the subject. The very intensity of the reaction which may cause death also usually indicates production of antibodies which, in non-fatal cases, may bring about speedy cure; and good feeding is almost all-important in convalescence. Also, the deleterious effect of good nourishment on acute febrile diseases is off-set by beneficial effect in chronic infections, such as many cases of tuberculosis and worm infestations.

This new knowledge provides no argument for under-feeding. It does show, however, that good feeding alone is not a panacea; it must be combined with protection from specific pathogenic germs.

H. E. H.

The Nutritive Value of Pasteurized Milk

Two conclusive experiments have been completed recently. The first, carried out for the most part at the National Institute for Research in Dairying, Reading, was with rats. The second, by Wilson, Minett, and Carling, was with calves of a herd belonging to the Berks and Bucks Joint Sanatorium. The results were the same, so the summary and conclusions of only one (that dealing with calves, as set out in the *Veterinary Record* for July 3rd, 1937, p. 823) need be given.

"An experiment on feeding of calves is described, which lasted over two years, and which was carried out on a healthy Shorthon herd free from tuberculosis and contagious abortion.

"Alternate animals as they were born were allocated, without any selection whatever, to one or other of two groups. One of these was fed on raw, the other on pasteurized milk. Every animal received its mother's colostrum for three and a half days before being put on the milk diet.

"The milk used was taken from the mixed morning's milk of the whole herd. It was divided into two parts, one of which was given raw, the other of which was submitted to low-temperature pasteurization at 145° F. (62.8° C.) for thirty minutes and subsequently cooled. The animals were fed morning and evening on measured quantities that were in strict relationship to their body weight.

"In addition to the milk, hay was allowed *ad lib.* Observations showed that practically none was eaten during the first month, after which each animal consumed about 1 lb. a day, rising to 3 lb. by the eighth week.

"With the exception of two weaklings which died after 15 and 23 days respectively from causes apparently unconnected with the nature of their diet, all the animals—25 in the raw and 23 in the pasteurized group—throve well, and showed no obvious signs of rickets or anæmia.

"The average increase in weight over the eight-week period for the animals in the raw group was 53.72 lb., and in the pasteurized group 53.86 lb., or 61.18 and 62.94 per cent respectively. This practical identity in weight increase is all the more surprising in view of the fact that the number of bull calves was very much less in the pasteurized than in the raw group.

"The highest individual gain among the bull calves (one of 80 lb.) and the highest individual gain among the heifer calves (one of 63lb.) both occurred in animals fed on pasteurized milk.

"At no time throughout the experiment was any observer, lay or professional, able to distinguish between the two groups of animals.

"The diet given, though permitting of good skeletal development, was insufficient to fatten the animals. After they had been transferred, however, to a normal diet at the conclusion of their eight weeks in the experiment, they soon put on weight and within two or three months were indistinguishable in size or condition from animals that had received a more generous diet from birth.

"There is nothing in these results to suggest that the nutritive value of pasteurized milk for calves is in any way inferior to that of raw milk."

2. A third experiment, with school children, is to be reported soon, but it is unlikely that the result will fail to confirm the findings with rats and calves.

As *Nature* (Sept. 4th, 1937, p. 391) puts it:—

"To sum up, pasteurized milk may contain less vitamin B (presumably B_1) and vitamin C than raw milk, but will in other respects have the same nutritive value. Where milk is not the sole diet, such losses will have no significance. provided the diet also contains cereals and fruit. Where milk is the sole diet, a supplement of fruit juice and a yeast extract or other rich source of vitamin B_1 should obviate any possibility of the diet being inadequate in these respects, although, with a proper intake, the lower content of pasteurized milk in vitamin B is unlikely to be detected, and it is now usual to supplement the milk with fruit juice (together with vitamins A and D, in the form of cod liver oil or a concentrated preparation of these vitamins). These experiments suggest that there need be no fear of malnutrition from the universal use of pasteurized milk; admittedly the risk of infectious disease will be considerably reduced."

3. It is to be hoped that we shall hear no more of the evils of pasteurization, for these evils simply do not exist. But by pasteurization is meant heating for thirty minutes at 145° Fahr.; not the weird assortment of heatings that all too frequently are given that name. H. E. H.

Sprouted Grain Costs

There appears to exist some doubt whether the feeding of sprouted grain is an economic proposition in Kenya and for this reason figures based on actual costs in experiments carried out at Njoro are quoted. These costs are based on prices for the cereals which, it will be noticed, are considerably higher than the average prevailing over a period of years.

It will be noted that these costs are extremely low compared with those prevailing in other countries, where the cabinet system and heat are used. There can be little doubt, therefore, that the process is of considerable economic value for Kenya, particularly for farmers who are dairying in the drier areas.

Cost	Number of lb. of sprouted grain per 1 lb. dry grain	Cost of dry grain per ton of sprouted grain
Barley at Sh. 7/50 per bag of 180 lb.	$4\frac{1}{2}$	Sh. 19/92
Oats at Sh. 12 per bag of 130 lb. ..	$4\frac{1}{4}$	Sh. 47/43
Maize at Sh. 8 per bag of 200 lb. ..	3	Sh. 29/88

Working costs are as follows :—

	Sh.	*cts.*
Depreciation on store and trays, per ton	6	50
Newspaper, sundries, water, etc.		30
Labour and supervision	3	00
	Sh. 9	80

Total cost per ton—

Barley ..	19/92 plus 9/80	29	72
Oats ..	47/43 plus 9/80	57	23
Maize ..	29/99 plus 9/80	39	68

Compost-Making Without Watering

By C. R. TOFTE, *Kitale, Kenya Colony*

This article describes the final technique, evolved after several months of experiments, for preparing large quantities of compost simply and cheaply from a single material, Napier grass (*Pennisetum purpureum*), with the aid of twenty-eight head of cattle. The conditions did not allow of artificial watering. At least 1,200 tons of a compost, with the important quality of good division, are made yearly. On the average, the material is in the stack ninety days.

The Napier grass is planted on land adjoining the coffee which is to receive the finished compost, usually on steep slopes, where it would be difficult to carry water except at great cost. To reduce the distance that the bulky material must be transported, cattle *bomas,* measuring 42 ft. by 20 ft., without roofs, were built at intervals alongside the Napier grass.

METHOD OF MANUFACTURE

Building the Stacks

The cycle of work starts at the lowest *boma,* No. 1. Napier grass is cut when not higher than 6 ft., chopped into sections, three to four inches long, and put down in the *boma* to a depth of 2 ft. Cattle bedded in the *boma* by night impregnate it with dung and urine. Six days later the work really starts. Boys are placed at regular intervals along the face of the Napier grass to cut it, chop it into sections and stack their task at points convenient for carting. Next day a sixth of the soiled bedding is removed and carted to the edge of the coffee. As each cartload is removed it is replaced with fresh Napier grass. Two cartloads of coffee pulp are also carted to the composting site.

Two boys build the stack, which is 36 ft. long and 9 ft. wide. Firstly, chopped Napier grass is laid to a depth of fifteen inches, then a thin layer of bedding, approximately one and a quarter loads, followed by a thin layer of coffee pulp. Upon this is laid chopped Napier grass to a depth of eight inches. The stack is now trampled to compact it. Further layers are added until all the bedding is used, and the heap is compacted after each layer of chopped grass. The stack is completed with a thick layer of coffee pulp and again compacted. Every week-day the same procedure is followed; one-sixth of the soiled bedding being removed and replaced by fresh chopped grass. In this way all the bedding has cattle sleeping on it for at least seven days before going into the stack.

Six days before the grass cutters reach a point midway between *bomas* Nos. 1 and 2 the latter *boma* is bedded down and the cattle moved to it. Thus, when all the bedding in No. 1 has been carted, that in No. 2 is ready.

Turning the Stacks

First Turn.—Approximately sixteen days after building the stack is turned for the first time. The time depends very largely on weather conditions; during very rainy weather it is found that the stack should be left up to twenty days before turning. In turning, one load of either bedding or pulp is incorporated into the stack. In order to ensure that the material on the outside of the heap decays evenly with the rest, care must be taken to place it well inside the new stack. On completion the stack is again well trampled.

Second Turn.—Three weeks to a month later, depending on weather conditions, the stack is turned a second time, and again one load of bedding or coffee pulp

is incorporated. Here, too, the stack is well trampled down.

Usually two turns only are needed. During very wet weather it may be advisable to turn a third time, as the stacks are liable to cool off after continuous soaking. The temperature rises immediately after turning; temperatures up to 156° F. were measured.

Approximately one hundred acres of Napier grass are needed for carrying out this programme continuously. Each stack of the size mentioned provides about five tons of finished compost.

Labour and Cost

1 Boy cutting standing Napier grass.
15 Boys chopping into pieces.
4 Boys working with two carts, including two *totos* leading oxen.
2 Boys building stacks.
2 Boys turning stacks.
2 Boys spreading finished compost in coffee.

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With labour at Sh. 9 a month and maize meal at Sh. 11 a bag, the total daily cost for making compost and spreading five tons in coffee works out at Sh. 10/66. The depreciation on the carts and oxen is not included.

Possibly, when the boys become fully familiar with the routine, the tasks can be increased and the cost reduced.

General

The most important points in this technique appear to be:—

(1) The use of succulent, immature Napier grass, the water of which keeps the stacks moist and thus the temperature high. The Napier grass should be used as soon as possible, the following day for preference.

(2) The shortness of the material used, which ensures close packing and thus prevents the stack from drying out and losing heat.

These are at variance with two of the principles laid down for the Indore method, namely:—

(1) The use of mixed bedding which maintains an open texture throughout the process.

(2) That all green plants must be wilted by being spread out in thin layers in the sun for at least two days before use.

The technique of the Indore process requires large quantities of water. On most farms the provision of a constant supply of water at the compost factory would be an expensive item. Again, varying weather conditions renders it impossible to lay down a set programme of watering, thus constant supervision of the unskilled labour would be necessary, an impossibility at certain times of the year, as during coffee picking. In this technique advantage has been taken of the natural water-content of the bulk material to prepare a usable compost.

The process was worked out by the writer in conjunction with Mr. Roger Norton at Kacharoba Estate, Kiambu, during 1936.

The Eucalyptus Weevil, *Gonipterus scutellatus* Gyll., in Nyasaland

By C. SMEE, *M.C., D.I.C., F.R.E.S., Entomologist, Department of Agriculture, Nyasaland Protectorate*

In March, 1937, when searching eucalyptus trees in Zomba for tea mosquito-bug (*Helopeltis bergrothi* Reut.), the writer discovered this weevil in considerable numbers. Its presence in the country had not been recorded before, and as it is not considered to be an insect indigenous to Africa, though known for some years as a pest of eucalyptus in the Union, its discovery in Nyasaland is of some interest.

The insect and the damage it does are fully described in the *Journal of the Department of Agriculture* of the Union of South Africa for November, 1924. It is thought that this weevil was probably introduced into South Africa prior to 1916 in consignments of apples from Australia, its original home being in Tasmania, whence it spread to New Zealand and Australia.

Its distribution in South Africa since its discovery there in 1916 has been found to be somewhat extensive, though not continuous, from the Cape Province to Lydenburg in the Transvaal. It is, however, apparently absent from Southern Rhodesia, and has not, as far as the writer is aware, been recorded from any part of Portuguese East Africa.

When and how it reached Nyasaland is therefore obscure, but as it has, up to the present, been found to be fairly widely distributed over the southern third of the Protectorate, with the possible exception of the very low elevations in the extreme south, it has probably been in the country some years. It has not yet been found north of Zomba nor at the higher elevations (above 3,000 feet) on Zomba mountain.

For some years after 1916 the weevil, in both the grub and adult stage, caused very severe damage to certain kinds of eucalyptus trees in South Africa. No effective and economic means of control could be discovered until in 1926 a minute parasite (Mymaridae: *Anaphoidea nitens* Gir.) of the eggs of the weevil was introduced from Australia, bred in large numbers and liberated in attacked plantations. The parasite became established in most districts and appears to be efficient in keeping down the numbers of the weevil, except in some parts of the high veld.

Now it is an extremely interesting fact that this egg-parasite is also present in Nyasaland, distributed equally with the weevil, and laboratory observations have shown a parasitism of 80 to 90 per cent. This is a very satisfactory state of affairs which, together with the fact that the weevil has already dispersed over a considerable area and yet serious damage to eucalyptus trees has not been reported or observed, indicates that the insect may not become a pest of primary importance under local conditions. Provided the parasitism remains at its apparent high rate and is not suddenly reduced by any climatic changes, it seems probable that the weevil will naturally be held in check. Its potentialities for seriously damaging young eucalyptus foliage, whether at the summit of full-grown trees or on regenerated sucker growth, are, however, very considerable, as both the adult weevils and the grubs feed voraciously for some length of time on the young leaves and

shoots. This continual feeding induces a proliferated and weak growth of new shoots and may finally result in the death of the growing points.

The grubs are slug-like, somewhat slimy in appearance, yellowish-green dotted with black, and usually found with a long, curled thread of black excrement extruding from the hinder end. They are a little less than half an inch in length when full grown and pupate in earthern cells below ground level, from which the adult weevils emerge after a month or more.

The feeding marks made by the grubs in their earlier stages are narrow, parallel-sided strips, frequently eaten out of one surface only of the leaf. Older grubs and the adult weevils will also scallop the edges of the leaves, but as other beetles produce a rather similar type of damage this is not so characteristic.

The eggs are laid in small dark brown capsules composed of hardened excremental matter glued to either surface of the young leaves, and these capsules, containing from five to sixteen eggs, look very like isolated droppings from caterpillars.

Up to the present, that is from March to September, breeding by the weevil appears to have been continuous, fortunately accompanied by heavy parasitism of the eggs. In addition to this parasitism there is some unknown agency that destroys the egg-capsules before hatching occurs.

In South Africa the susceptibility of various species of eucalyptus to damage by this insect has been carefully studied, and a comprehensive list of the various categories was published in *Farming in South Africa,* April, 1933. The degree of susceptibility will vary somewhat with the conditions under which the trees are growing, and no absolute immunity from attack for any species can be assured. Some species that have suffered most in South Africa and are known to be present in Nyasaland are *E. viminalis, punctata, globulus, maideni, sideroxylon, robusta,* and *rostrata,* the last two certainly being attacked here. Similarly, species thought to be more or less immune include *E. cladocalyx, botryoides, citriodora, crebra, ficifolia, maculata, microcorys, paniculata, pilularis, saligna, siderophloia.* But *E. saligna* has been found to be slightly attacked in certain areas in Nyasaland.

The weevil is reputed to feed on the foliage of apple trees in the Australian continent, but it has not yet been found doing so in South Africa, though its distribution there coincides with the apple-growing districts and it is stated that adult weevils may enter packing sheds for shelter during the cold weather. The possibility that the weevil reached Nyasaland in consignments of apples from South Africa, in the same way as it is thought to have reached South Africa from its original home, is plausible. The beetle itself could easily survive such a journey, and its present known distribution here covers roughly the most likely stretch of country in which it might have been liberated from such consignments, its local dispersion being aided by its own powers of flight or by hiding in motor transport vehicles.

But the presence of the egg-parasite, which, on comparison with material from the Union, appears to be identical with that specially imported into South Africa from Australia, postulates that parasitized egg-capsules must have reached this country somehow, as the parasite lives only on the eggs of the weevil. It appears that egg-capsules have been found only on eucalyptus trees in South Africa, and though they might conceivably get mixed with seed and thus be transported some

distance, the maximum period (exclusive of such factors as cold storage, which would not be employed for seed) for the development of the parasites in the weevil egg-capsules, their emergence and their ovipositing in a fresh supply of capsules, would seem to be little more than four weeks. If it is correct to assume that the weevil has been present in Nyasaland for a few years, the lack of rapidity in inter-territorial communications not so very long ago rather precludes this possibility.

It might be suggested that living plants carrying both healthy and parasitized egg-capsules, transported under cold storage conditions, could have been the means of introducing both host and parasite, but it is extremely improbable that importations of eucalyptus into Nyasaland have ever been made in this manner.

The alternatives appear therefore to be either that the introduction of both host and parasite has been made through the importation in cold storage of some kind of living plant not yet associated with the weevil as a food-plant, or that both insects have spread naturally wherever eucalyptus trees exist, on a much wider scale than has been realized, and have now a greater continuous distribution through South and Central Africa than is at present on record.

Central Agricultural and Scientific Bibliograpy

Modern mass production of scientific and technical literature led first to the growth of comprehensive abstract services which, as literary proliferation increased, have tended to bury the references to aruicles on specific subjects in the mass of abstracts on all subjects. Thus has developed the present day demand for specialized bibliographies—lists of references classified according to the titles of the articles noticed, and informing about the quantity rather than the quality of scientific literature. A comprehensive bibliography on all branches of agriculture and allied subjects is now being organized at the Science Library, South Kensington, London, S.W.7. As the Library takes most of the four thousand or so agricultural journals published throughout the world, it offers unusually good facilities for the preparation of such a bibliography. Subscribers, paying 10/- per annum as individuals or £5/5/0 as institutions, will have full access to the bibliography and special facilities for reference to books in the Library. Translations and abstracts will also be made. The service commenced on 1st March, 1936. (*Nature*, Vol. CXXXVII, No. 3464, p. 489.)

Notes on Trials of Ramie in Tanganyika Territory

By J. C. EYRE, B.Sc., *Agricultural Officer, Department of Agriculture, Tanganyika Territory*

Ramie was introduced many years ago into Tanganyika Territory. There are now a number of small acreages in the Tanga and Moshi districts, but the only planting of any size is one of some thirty acres near Pongwe in the Tanga district, and a smaller one on an estate in the Nguu Hills of Handeni. There has been no recent extension of planting in the Tanga area, and the planter who laid down the large area now considers conditions on his estate to be unsuitable for this crop.

The variety mainly planted was *Boehmeria nivea*; *B. utilis* is only being grown on a very small scale owing to lack of planting material. There is no very noticeable difference in the response of these two species; *B. utilis* produces a somewhat longer but proportionately thinner stem. Observations have been made on the crop planted in both good and bad situations. It usually flourishes during the first year or two, providing there is sufficient rain, after which it very rapidly deteriorates. The stems become progressively shorter and thinner, and harden up very much more quickly, while at the same time the number of stems on a given area rapidly increases. Often, however, ramie shows poor growth even in the first year or two, like that on the Sisal Experiment Station at Ngomeni. From observations it appears that to make an economic success of the crop—apart from marketing considerations—it will be necessary to find some means of controlling the increase in the number of stems and probably also to manure.

The cost of establishing 36 acres in the Tanga district amounted to Sh. 5,323/50, which included the cost of clearing the land of fairly heavy rubber and also of cleaning a part of the area for three years. On another estate the cost of clearing, planting and cultivating up to the time of the first cutting was said to be approximately Sh. 50 an acre. The accuracy of the figures is, however, doubtful.

The cost of maintaining a plantation is not available, since both estates have allowed their areas to revert partly to bush. It is thought, however, that the cost of upkeep, even without manuring, would be high, since the land would have to be clean cultivated and the number of growing stems controlled.

No accurate figures of yield are available, since on each occasion that any quantity of material was harvested the area had to be searched for sufficiently long stems and only these were cut. On a good site and under favourable conditions, stems up to six and seven feet high are obtained in the first year, but in the third year or when the rainfall is insufficient the average height is not more than three and a half feet.

Apart from questions of decortication and marketing, booms in ramie growing in Central and South America and in India, and the subsequent failure of the enterprises, must to some extent be attributed to the fact that during the first year or two of growth the plant flourishes and looks extremely promising, but thereafter rapidly deteriorates. The inferior fibre must be sold in competition with hand-produced China grass grown under a very intensive system of cultivation, from which profits cannot but be meagre.

Treatment and Marketing of the Fibre

The usual form in which ramie fibre is marketed is as "China grass", produced in China by a very tedious process of hand stripping and scraping the strips with small knives or bits of sharpened bamboo. The material is then washed and dried. In spite of his presumed expertness, the Chinese worker does not produce more than one kilogram of cleaned dry fibre per day.

In addition to this treatment, certain quantities of gum must be removed from the fibre by the manufacturers, by a process specifically designed to deal with the Chinese material. It is said that imports to Europe amount to only 4,000 tons per annum, and that further supplies of China grass would be available if required. At the close of 1936, when sisal was £28 per ton, first quality China grass could be bought for £37 c.i.f. London, with lower grades at £27 to £30 and rejections at £22 to £25. It has been recognized that it would be difficult to produce hand prepared China grass in competition with the Chinese; machines designed to emulate their methods have failed to produce the same material. Different chemical processes have been tried to remove the gum from the bark and extract the fibre intact. It was thought recently that satisfactory processes had been found.

Consignments of hand-stripped bark and machine-produced material untreated and treated by different physical and chemical methods were prepared and forwarded to London, but so far no guaranteed market has been found. The first consignment of hand-stripped ribbons, consisting of 100 lb. of shade-dried material, was forwarded to London; it was reported that the material was not entirely satisfactory, and it was said to be immature. A further consignment of 230 lb. was forwarded, but no report has been received.

It was found that the cost of cutting and stripping alone amounted to a little over £21 per ton. The labour was, however, mainly inexperienced. Three different methods of stripping were tried; the quickest way was to break the wood in the centre of the stem without breaking the bark except for longitudinal slits in it, insert the forefinger of the left hand and pull the stem with the right.

Even if the labour costs of cutting and stripping could be reduced to £5 per ton of dried material, it is doubtful whether production could be regarded as economic with a c.i.f. value of £20 per ton, a price that has been offered. Freight alone would be a heavy item, probably amounting to not less than £3 per ton weight, since the material cannot be compressed to the same extent as, say, sisal.

It has been stated that the cost of removing the gum amounts to £30 per ton, and the resultant material would be valued at £60 per ton. Up to the present there appears to be no open market for bark strips, and planting could not be advocated unless very substantial financial guarantees were given by the patentowners who have interested themselves in the production of ramie in East Africa. Contracts have been offered to planters at £20 per ton for dried material; so far, to the best of my knowledge, no planters have accepted this offer.

As stated, shipping freights from East Africa are high, and it is doubtful whether it would be economic to ship material only 40 per cent of which was of actual value, and then only after being treated by elaborate processes. If the actual fibre material required for eventual commercial manufacture could be produced in this country, the position would be different. But in any case it is difficult to

understand how £20 per ton can be offered for bark strips, 60 per cent of which is waste, when China grass rejections, from which actual waste would probably not amount to more than 20 per cent, can be bought for £22 per ton.

One ton of dried ramie stems was supplied to an interested firm for experimental purposes. The stems were obtained from a planter who was paid at the rate of £15 per ton f.o.b. Tanga. No reports were received and since no further orders have been placed it is presumed that an outlet for the material could not be found.

When it was found that the preparation of ramie by hand would probably not be economic on plantations, a small machine was bought by the Department to test the possibilities of machine-produced material. In essentials, the machine, driven by a 1 h.p. engine, is a small drum to which are attached pieces of T iron acting as knives. The machine is hand fed, the knives beating the material against a sprung breastplate. The manufacturers state that the knives should be so adjusted that they lie parallel to the breastplate; this was tried, but it was found that only a very small proportion of the outer bark was removed, and in addition a large quantity of the wood still remained adhering to the fibre. Afterwards the knives were set at an angle to the breastplate; the stems were inserted at the wider end, which broke the wood, and then pulled towards the other side, where the more closely adjusted knives removed the pellicle.

Three separate trials were made near Tanga with the machine as material became available, but the output cannot be considered in any way satisfactory. In the last trial 14.82 kg. of dried fibre was produced in ten hours running time from 20,000 stems weighing 960 kg. stripped of leaves, the recovery being only 1.5 per cent. In the previous trials the recovery was up to 4.8 per cent, but the unwashed material produced contained all the gum and a high percentage of bits of wood and pellicle. One experienced worker fed the machine and another handed him the stems. In further trials at Moshi two men fed the machine and the output was nearly doubled, but still it must be considered inadequate. The machine is supposed to produce 125 kg. of dry fibre in nine hours, but judging from the trials made here this is impossible unless the product contains a very high percentage of the woody material.

The first samples of machine-produced material were forwarded to England and reported as better than hand-cleaned China grass; at the same time it was said that the dirty brown colour would be detrimental on the general market, although for the special purpose required it would not be. A report on the same samples from a firm of brokers was not in the least favourable; they considered the samples inferior to any material shipped from China, and valued it at £15 per ton c.i.f. After decortication the particular material forwarded had been washed in hot water and shade dried. These samples were sent to a third person who required the material in ten-ton lots, but nothing further transpired.

Fifteen further samples of material treated in different ways were forwarded, and at the same time some untreated fibre. The treatments consisted of washing, boiling in water, and boiling and dipping in salt solutions and washing powders. The samples were submitted to the potential buyer, who did not consider any of them suitable for his purpose, and suggested other treatments, which had already been tried and found to have no effect, by dipping in 2 per cent salt and soda solution and subsequently drying

under glass. He also changed his mind in regard to decortication, and said he now thought it unnecessary. It is considered that the hand-stripped ribbons he requires could not be produced economically at the price he is prepared to offer. It was stated that all the wood must be removed, which the machine will not do.

The samples were also submitted to a firm of brokers, who did not regard them at all favourably, the main faults being short length and very poor decortication. This firm expressed the opinion that it would be a waste of time for East Africa to concentrate on ramie unless the production costs were exceptionally low and a very high standard of quality was maintained. They state that China could meet the present entire European demand, which could be put at no more than 4,000 tons. Another firm of brokers did not regard the material as satisfactory and said that the samples were very much inferior to China grass rejections; moreover, the market for China grass was at a very low ebb.

A last batch of samples was sent for expert opinion to the Imperial Institute, which reported that none of the treatments tried had removed any considerable quantity of the gum, although boiling first in 14 per cent salt solution and then with washing powder and subsequent washing in 1.5 soap solution removed a small amount. The material was, however, still of a dirty appearance. None of the samples showed any resemblance to the usual form in which ramie imported into the United Kingdom is marketed. The samples were submitted to one of the principal ramie spinners, who stated that if we could supply ramie as exported from China they would be interested, but not otherwise.

Summary and Conclusion

Certain quantities of ramie have been grown in the Tanga Province. The plant flourishes in the first year or two, providing there is sufficient rain, but subsequent growth is poor.

There is an open market for hand-cleaned China grass which it would not be profitable to enter, because production costs are high and China is able to meet all demands. Dried strips were forwarded to interested manufacturers, who offered £15 to £20 per ton c.i.f. The material could not be marketed at this price with a profit to the grower, and in any case would not be saleable on the open market.

A small decorticating machine was obtained, but its out-turn of dried fibre was too low to be profitable; also the fibre was not properly decorticated, was of poor colour and bore no resemblance to China grass. Different treatments, designed to produce a clean white material, were not successful.

The Imperial Institute reported fifteen samples, treated in different ways, to be unsatisfactory and unsuitable for the open market.

Without new methods of decortication and treatment, and a guaranteed market, ramie planting would be a hazardous enterprise.

Sprouted Grain as a Stock Food

By R. S. BALL, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Department of Agriculture, Kenya Colony*

Sprouted grain as a stock food has become increasingly popular in Europe during the last few years since it provides a succulent and very palatable feed which can be used safely for any class of stock. Experiments have been carried out in this country and it has proved to be very easy to prepare, since the relatively high temperatures generally experienced make it unnecessary to use any artificial heat in the sprouting of the grain and very little equipment is required. An additional advantage of this food is the rapidity with which it can be prepared should other sources of feed supplies fail unexpectedly or supplies of succulent material become scarce. On an average, a period of thirteen to seventeen days only is required to prepare the grain, although this time will vary according to the day and night temperatures. The greatest growth is obtained when the temperature can be maintained fairly uniform throughout, which can be most readily achieved by growing the grain in a fairly thick-walled mud and wattle store with a grass roof.

The chief advantages of sprouted grain may be summed up as follows:—

1. It is extremely succulent and palatable to all classes of stock.
2. Feeding of sprouted grain is believed to increase fertility of the stock.
3. It is a semi-concentrated food which can be fed as a production ration.
4. It is useful for converting grains which would not otherwise be palatable, or which may not be very digestible, to a digestible and palatable form.
5. It can be readily prepared and requires no elaborate equipment.
6. It can be quickly brought into use when other feed supplies have failed.

Any of the cereal crops, maize, wheat, oats, barley or rye, can be used for the purpose, oats and barley having proved outstandingly successful in Kenya. Good grain should be used, which is dry and free from mustiness, but it is not necessary to use best seed qualities.

It is desirable to have a dark store for the purpose, since germination will be quick under these conditions, but almost any convenient building will serve. A mud and wattle shed with a grass roof is probably as suitable as any. The grain is sprouted in trays, a convenient size for which is 3 ft. 6 in. by 2 ft. 3 in. These should have ends at least seven inches high so as to allow room for the germinating grain when the trays are stacked one above the other. The trays should have bottoms made of wire netting—one inch mesh has proved suitable—and these are covered with newspaper before the grain is spread out on them.

The grain is completely covered with water for a period varying from twenty-four to forty-eight hours before spreading on the trays, the longer period being necessary for maize and the shorter for oats and barley. With maize it is desirable to add formalin at the rate of one tablespoonful per three gallons of the water used for soaking.

This will prevent the formation of moulds in the sprouting grain. The addition of formalin is unnecessary for oats and barley since no tendency is exhibited to mould formation. After soaking, the water is poured away and the grain spread

out to a depth of three-quarters to one inch on the trays, leaving a space of at least two inches all round the edges to allow for the expansion which takes place during growth. Maize, however, should be spread to a depth of one and a half to two inches, as it tends to dry much more readily than the other grains. The grain is then covered with newspaper and the trays stacked in tiers in the store. They should be watered twice daily, unless the store is completely enclosed, in which case once is sufficient. A hose is the best means of doing this, but the grain should be just thoroughly sprinkled, not soaked, and covered again with the newspaper afterwards. Experiments are being conducted with the use of sulphate of ammonia and other nutrient substances in the water, but results to date have not shown any definite increase in bulk due to these. The rate of growth of barley was slightly accelerated by the use of sulphate of ammonia (two ounces per three gallons of water), but germination was not so good as on the control trays, so that the total bulk of material obtained was no greater. Further experiment is, however, being carried out with the use of these solutions, and it is hoped that more definite results will be obtained. When the sprouts are half an inch to one inch high the newspaper should be completely removed. The following table shows the length of time required to sprout the different grains under the described temperature conditions. The store was not an ideal one for the purpose, owing to the wide temperature variation, but nevertheless very successful results have been obtained. Earlier trials carried out in a store where temperatures only varied 20° resulted in quicker maturity of the sprouted grain.

	Fahr.
Average maximum temperature	86°
„ minimum „	47°
„ daily „	65·8°

Grain	Hours steeped	Number of days sprouted	Number of times increase in bulk	Average length of shoot
Maize ..	48	16	2·5	5½ in. to 6 in.
Barley ..	24	13	4·1	4½ in. to 5¼ in.
Oats ..	24	15	4·2	4½ in. to 5 in.

From the above it will be seen that 10 lb. of maize will yield 25 lb. of sprouted grain, 10 lb. of barley 41 lb. of sprouted material, and 10 lb. of oats 42 lb. of sprouted material at the optimum time and condition for feeding. The figure for maize can undoubtedly be increased as the average figures noted in the above table include yields obtained when the maize is spread only three-quarters to one inch thick, which did not prove adequate.

For trays of 3 ft. 6 in. by 2 ft. 3 in., the following amounts of grain will be required for barley and oats spread to a depth of three-quarters to one inch and for maize to a depth of one and a half to two inches:—

Barley	10 lb.
Oats	10 lb.
Maize	20 lb.

Feeding of the Sprouted Grain

If the grain has been sprouted in the dark, it should be moved into the light for a day prior to feeding, but otherwise it will be ready to feed directly. It will be found that it can be rolled up off the tray in a solid mat and conveniently carried about. It should be fed as soon as possible after it is ready; otherwise it is liable to deteriorate in quality owing to the exhaustion of reserve food material in the grain. In order to feed the material it is cut into squares and each animal given a square. At first, however, it may be necessary to incorporate this with a meal

mixture so that the animals may become accustomed to eating the roots and remains of the grain, or they may tend to eat only the young shoots.

The food can safely be given to all classes of milking cows, dry stock, calves, fattening cattle, pigs and poultry. Care should be exercised at first, since if fed in excessive quantity it would be liable to blow the stock.

Sprouted grain can be fed to cattle to replace in part the concentrated food and in part the roughages. Eight to ten pounds daily of the material can safely be fed to high-yielding cows, while young stock, rearing calves, etc., should be fed three to four pounds, depending on their age and other foods available.

For poultry the food can be used to replace approximately half of the mash and half of the corn ration, and should be fed at the rate of two to two and a half ounces per adult bird per day, or approximately one square inch per bird per day. A square of the material should be placed in a covered trough and the birds allowed to peck at it. It should not be placed on the ground or they scratch it about, causing a certain amount of waste. It is very valuable as a source of green food for the laying birds during the dry season, after supplies of kales, cabbages, etc., may have become exhausted.

Experiments carried out in other countries have shown that sprouted grain is particularly useful for replacing in part the rations normally fed to stock, since on account of the readiness with which it is digested the remainder of the ration is in itself more completely available.

Notes on the Cultivation of Passion Fruit in Kenya

By J. E. A. WOLRYCHE WHITMORE, *Rongai, Kenya Colony.*

At a time when a large number of farmers are considering planting passion fruit, it may be as well to point out a few of the things to be avoided. The Company with which I am connected first started putting in passion fruit about four years ago in the Trans Nzoia, and since then we have learnt by experience some of the snags that can be avoided. Conditions in Kenya certainly appear admirable for the growth of *Passiflora edulis,* if one judges by the way uncared-for vines ramp all over the place and produce heaps of fruit; but plantation conditions are different, and it does not necessarily follow that the vines will do equally well.

To a large extent one naturally follows the experience of other producing countries, but we have probably got to adapt our methods to suit local conditions, and these may have to vary from district to district. To those who are starting planting I would suggest that they should for preference start with virgin land, protected from high winds if possible. If not, a windbreak should be at once planted on the exposed side. Wattle will in many places be suitable, since it grows quickly and the poles at four years old may be of great use in trellising. Get the land really free from couch before planting. Several good ploughings are advisable. The question of whether to manure broadcast and plough under before planting or manure each individual vine when planted requires experience which we have not yet got. Roots of old trees should be deeply grubbed, as they may harbour *Rhizoctonia.*

I would most strongly advocate broad-base terracing the area before planting, making the terraces really strong so that it will be possible to plough and cultivate right over them. The direction of the planting is generally more or less north and south in other countries, so it will probably be as well to follow this. Grow your own seedlings and have them ready at about four months old when your most suitable planting month comes round. Discard the weak ones ruthlessly, and see that you have no eelworm in your nursery. Some of the plants I have seen have been badly infested, and looked as if they were covered with nodules, as in some legumes.

The general practice in other countries seems to be to have the rows 9 or 10 ft. apart and plants about 18 ft. in the row. Personally, I prefer the rows 10 ft. apart, as it gives more room for taking implements up and down. It is probably advisable to make holes beforehand, as for coffee; and some manure or compost at the bottom will probably be all to the good. Passion fruit is just as much a main crop as coffee, and the failures in other countries appear to have been generally where farmers have treated it as a sideline.

In planning one's acreage it is essential to arrange supplies of posts for the trellis, and the minimum number wanted is about 150 per acre. Intermediate posts need to be not less than 8 ft. long by 3 in., and strainers 9 ft. by 8 in.

As the vines may last five or six years, and you may decide to interplant as they go off, you have to put up something that will last ten years. Cedar, if you can get it, is obviously the best, but wattle or gums, if treated with some wood preservative, may do all right, especially if you can put a few cedar posts every now and then and take particular care over the strainers. The latest practice seems to be

to put one wire either on top of the posts or through them near the top, with another about 15 inches low down, and to space the posts about 30 ft. apart. Do not leave the trellising to the last moment, but start on it as soon as you have planted your seedlings in the field. It is quite an undertaking to put up 20 acres of trellis. We put the intermediate posts 2 ft. in the ground and the strainers 3 ft., and the latter want well bracing.

While wire is a very expensive item in one's cost, it is questionable whether it is economical in the end to put up a very light gauge. One grower is using 16 gauge steel, and only one wire. This may be all right in certain areas not subject to high winds, but appears very risky for others. I can imagine few more difficult jobs than getting up a row of vines which have collapsed from a broken wire. In Queensland they use either 8 gauge fencing wire or 10 x 12 oval steel. In any case, 11 x 13 steel seems about as fine as one should use at first.

Having got the plants in and the trellis up, you have to put in a light stick firmly beside the plant and tie it to the wires above. As the plant grows it must be tied to the stick about every nine inches until it reaches the wires, care being taken to loosen the ties as the vines thicken.

We made the very great mistake of pruning a young plantation too hard; just enough should be done in nipping off the points of shoots to encourage the main growth in two or four stems. To protect the stems, leave on as much leaf as possible. Some people go in for single stem, some double, and some four stems, but this must be a matter for experience in each district. The multiple stems are said to mature earlier but not to last so long. Over-pruning and baring the stem has, in our own experience, been undoubtedly one of the factors conducive to a bad attack of root disease (*Rhizoctonia*), which has very seriously affected one plantation.

Great care must be taken in handling the stems which are to be the main leaders on the trellis; they bruise very easily and should not be allowed to get sharp kinks. As these leaders grow, do not allow them to hang only from the tendrils, but keep giving them a turn over the wire every few inches, so that the whole weight of the vine is evenly carried by the trellis. The leaders should be encouraged to throw down their fruiting spurs vertically about every eight inches along the wire and not twine along it. The pruning should, at first anyway, be confined to stopping back the fruiting spurs which want to break out everywhere before the leaders reach the wires. The boys tying up have to keep coming back at least once a fortnight as the vines grow, adding extra ties. Do not economize in ties, as the sooner you can get the vine on to the wires the better.

It is important to keep the ground round the vine well worked; do not allow it to get hard and caked, as the vine likes a well aerated soil. A regular green cropping with legumes in between the rows will probably pay. Where you have broad-base terraces, avoid planting in the furrow where water might be inclined to stand; good drainage is essential. At about 14 months from planting some of the vines should begin to crop, and by 21 months should have pretty well covered the wires. The next two years will probably be the highest yielding ones.

While the system of two wires vertically placed is probably the easier to put up, it would be as well to try some rows with the two wires supported by a hardwood crosspiece, about 24 in. x 2 in. x 1 in., at the top of the post. The crosspiece should

be notched into the post and have saw-cuts at each end into which the wires drop. It is important to get plenty of sun and air through the vine, as this will help to prevent some of the diseases to which it is subject, particularly under humid conditions. The cost of bringing one acre of vines into bearing, unless all the timber is available on the farm, will be some £12 to £15, starting from virgin land and not charging for white supervision or the cost of the land. Some people may do it for a bit less, but it would be unwise to calculate on it.

An Adjustable Separator Mounting for Portable Dairy Unit

By C. D. Hill, *Rongai, Kenya Colony.*

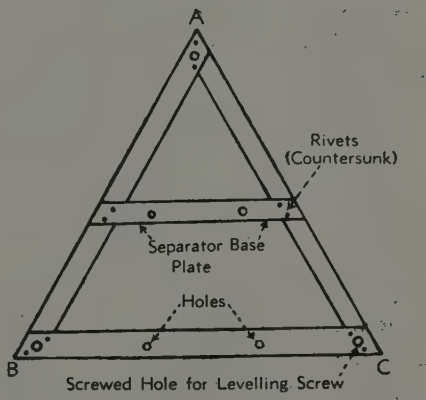
One of the disadvantages of the use of portable milking units lies in the fact that movements of the separator-house over uneven land frequently make it difficult to level the separator, this being usually performed by means of chock blocks which are hammered in under the skids. This method is unsatisfactory and liable to inaccuracies. Failure to adjust the separator on a level base will result in a certain loss of butterfat, and for this reason the method described below is likely to prove of some considerable value to farmers who use portable units. The method of mounting a separator on a table in a portable house described below is rapid and very accurate, and levelling can be performed independently of the ground surface on which the separator-house stands.

The following materials are required for the construction of this device, the size of which will, of course, depend on the size of the separator:—

$\frac{5}{8}$ in. x 2 in. flat iron, riveted with $\frac{3}{8}$ in. rivets.

$\frac{5}{8}$ in. x 6 in. bolts, threaded to heads. These will be used as levelling screws.

The iron is riveted in the shape of a triangle, as shown in the diagram, and a hole with a screw thread is made at each corner. This thread is made to fit the $\frac{5}{8}$ in. x 6 in. bolts.



The separator itself is mounted and fixed by means of four bolts, two of which are inserted on one side of the triangle and the other two on a cross-piece fixed for the purpose. The whole rests on the table.

When it is desired to fix the separator level, a spirit-level is placed on the separator and the screws turned up or down until the spirit-level reads level in both directions. This can be accomplished very quickly and with a high degree of accuracy.

Preliminary Notes on the Use of Elephant Grass as a Fallow Crop in Buganda

By G. W. Nye, *B.Sc., Dip. Agric., Senior Botanist, Department of Agriculture, Uganda Protectorate*

The rapid spread of cotton cultivation in Buganda within recent years has made it obvious that the old native method of resting the land is no longer possible, since sufficient land is not available. The general native practice with annual crops has been to cultivate the land for two to three years, after which it was abandoned under a natural fallow for a period of from seven to ten years. Long experience showed that this period was necessary and sufficient to bring back the land to a high state of fertility. Over a very large part of Buganda, Elephant grass (*Pennisetum purpureum*) is the dominant plant and there is no doubt that this plant with its big root development has been responsible, to a very large extent, for maintaining the fertility of Buganda soils. As soon as the problem of maintenance of fertility arose, investigations were made into rotation crops likely to have the same effect as a seven to ten years' fallow.

Owing to the imitation of economic annual crops to cotton, with groundnuts and sim-sim as very secondary ones, and to the fact that cattle cannot be successfully kept in Elephant grass areas, no rotation of crops using cattle manure as the regenerator is possible. Artificial manures are of course out of the question owing to the high cost of freight from the coast. Green-manuring has been tried extensively but with one or two exceptions only affected the crop immediately following the green manure, there being no residual effect whatsoever. Another serious objection to a green manure crop is that it is unlikely that a native will plant a crop merely for the sake of digging it in, especially if the crop is one with which he is unfamiliar.

In 1932, after it had become apparent that green-manuring was of little or no economic value, it was decided to put into practice a modification of the native methods, using a crop which was indigenous, with which everyone was familiar and which was obviously nature's own remedy for soil exhaustion, namely Elephant grass.

The Use of Elephant Grass

The distribution of Elephant grass in Buganda follows the Lake basin area, although it is also found outside this. The essentials for its optimum growth are an evenly distributed rainfall of over 45 inches per annum.

Under natural conditions Elephant grass is spread by seed and its luxuriant growth results in an almost pure stand and the killing out of most weeds. In native practice about three years elapse between the abandonment of land and the attainment of a good stand of Elephant grass, but this period depends on the state of the soil. If the soil is in an exhausted condition, such as frequently occurs in these days, Elephant grass takes a long time to become established. In a pure stand the grass is so thick that it is penetrated with difficulty and its height may be anything up to 15 feet, six months after planting.

As at least three years elapse after abandoning a plot before a perfect stand of Elephant grass is obtained, it was considered advisable to short circuit this process by planting the Elephant grass,

instead of leaving it to come in spontaneously. By this means the period of fallow is reduced by three years. The question then arose as to how many years land could be cropped before it should be put down to fallow. Without any experimental evidence to assist it was decided to take a period of three years, this being the period of old native practice and therefore very likely to be a reasonable one. The period of fallow also requires to be ascertained by experiment, but in order to make a start one of three years was taken, being commensurate with the amount of land available.

There are several possible methods of planting Elephant grass, all of which have been tested at Bukalasa.

(*a*) *Seed.*—This is the natural means of propagation. Trials of seed sown in rows and broadcast have been made. The germination varies considerably and for this reason alone propagation by seed is not likely to be satisfactory since no cultivator will re-sow three or four times. The viability of the seed may depend on the time of year when it is harvested and further work on this point is being done. The plants that do come away tiller better than those from other methods of planting and they reach the same height and stage of development after about six months. A further disadvantage of planting by seed is that a "clean" plot is required, thus entailing more labour than other methods.

(*b*) *Cuttings.*—Short 18 in. lengths of stem are pushed into the soil. It is essential for at least two nodes to be buried. This method has the advantage of being simple and quick and a "clean" plot is not necessary.

The cost of planting cuttings on the small-holdings at Bukalasa worked out at approximately Sh. 13 per acre. It has been found at Bukalasa that 2 ft. by 2 ft. spacing gives a satisfactory but not a perfect cover. It follows that the closer the spacing the better the cover, but the question of labour prohibits very close spacing. The adoption of 2 ft. by 2 ft. spacing would be satisfactory in practice and can be recommended with the knowledge that the cost is not prohibitive. Some idea of the rapid development of plants from cuttings may be given by the example of a small plot planted in October 1936. It gave by April 1937, plants (each from single cuttings) averaging 13 ft. 6 in. in height (Fig. 1) with an average of twenty-three tillers and a stool circumference of 4 ft. 9 in. (Fig. 2). An examination of the roots showed extraordinary development, the mass reaching a depth of 2 ft. with a lateral development of 2 ft. (Fig. 3). The chief disadvantage of cuttings is that if a dry spell occurs soon after planting many will dry out and large gaps occur which are difficult to refill owing to the mass of vegetation in the plot. If, however, the soil is really moist before planting a good stand invariably results.

(*c*) *Layers.*—This method is only practicable if the land is ploughed before planting. Long lengths of stem are laid in the furrows and are covered slightly with soil. If conditions are favourable every node sprouts and excellent cover is obtained in a very short time. A full ploughing is not necessary, furrows being laid at 2 ft. intervals. This method is used on the Cattle Small Holding at Bukalasa and costs only Sh. 7 per acre.

(*d*) *Roots.* — The most satisfactory method of all is to plant portions of root stock. This method entails somewhat more labour than cuttings but the result is almost invariably a perfect stand, as the root stocks can withstand dry conditions for much longer periods than cuttings. The cost at Bukalasa at 2 ft. by 2 ft. spacing was Sh. 25 per acre. A wider

FIG. 1
Showing plants 6½ months old planted from cuttings

FIG. 2
A close up of a single clump showing the large number of tillers produced from a single cutting in 6½ months

spacing however, can be used with roots than with cuttings, so that the cost might be considerably reduced.

As a pure stand Elephant grass produces such a thick mass of vegetation that practically all weeds are killed out. It is disappointing however to record that a three year fallow under this grass is insufficient to kill out couch grass (*Lumbugu*). Couch does not spread under Elephant grass but it remains dormant, ready to increase with great rapidity as soon as the land is opened up again. If the land is completely free from couch when it is put to fallow it is unlikely that couch will gain an entry but it is very difficult to attain this ideal. It is worth mentioning here that in planting Elephant grass roots care must be taken to avoid using any which come from a couch infected patch, since the couch roots are often intertwined amongst those of the Elephant grass and the weed may be easily spread in this way.

As soon as the plants come away after planting there is no possibility of soil erosion occurring.

FIG 3

A single clump 6½ months old originating from a single cutting. The extensive root system is clearly shown

No treatment of any sort is necessary, or desirable, during the fallow period, but the grass should be protected from annual firing in the dry season. When the land is to be reopened the grass must be burnt off before any cultivation is done. Without burning, the task of cultivation by hand is excessive; and the effect of burning is not serious as the beneficial

portion of the grass undoubtedly lies in the root-stock. It is possible to plough in standing Elephant grass with a powerful tractor but no ox plough can touch it.

The mass of stems and root stocks form a complete protection against soil erosion for at least a year after the land is reopened. There is however one important point to be considered. The surest way of destroying decaying vegetation is frequent cultivation; experience at Bukalasa has shown that "dirty" farming pays and the fewer the pre- and inter-cultivations the better the crops, the less soil erosion and the better the structure of the soil. Frequent inter-cultivation of cotton causes all the Elephant grass debris to disappear within six months, with the result that the solid becomes loose and powdery and soil erosion takes place.

The first crop after clearing is cotton, which is planted across the slope. All the debris on the surface is heaped between the rows, providing a certain check to erosion however steep the slope may be. Cotton is followed in the next year by early sown groundnuts, followed by cotton; and in the third year cotton is grown again, early sown and inter-planted with groundnuts and/or beans. As soon as this last cotton crop is uprooted and burnt Elephant grass is planted.

Experiments

A replicated experiment has been laid down at Bukalasa to find out the minimum period necessary for the fallow. Three periods: two, three and four years are under trial; each after three years of cropping on the rotation given above. Many years must elapse before complete results can be obtained and until then three years of cropping followed by three years of Elephant grass is the general rotation encouraged by the Department.

Conclusions

While the use of Elephant grass in the rotation is still in the experimental stage there is no doubt that it is an almost perfect regenerator of the soil. The objections to it are the labour of planting and the labour in clearing. A modification, possible only where cattle are kept, is to cut Elephant grass for fodder and bedding and apply the resultant manure to the land. Whether this would maintain the fertility or not is an open question. Trials are being made on one of the smallholdings at Bukalasa and the first indications are that fertility is not maintained by use of manure alone. If on the other hand fertility can be thus maintained there will be no need for planting Elephant grass as a fallow crop since it would only be necessary to maintain a permanent plot for cutting. There should not be the same difficulty with clearing as with planting as it is an operation which cultivators have been accustomed to for generations.

There is little doubt that as soon as the Baganda can be convinced of the value of Elephant grass they will be prepared to try planting small plots for themselves. Much propaganda will be necessary, but the average Muganda farmer is prepared to adopt new methods provided that he is absolutely certain they are likely to increase his profits.

Maize Improvement in Kenya

Two methods have been adopted, namely the production of inbred strains for subsequent hybridization, and the advocation of mass selection by the grower. The first line of work has been centred at Njoro, where the main object is the production of types suited to the higher limits of maize growing, and at Kitale, where attention has in particular been given to resistance to Fusarium diseases and to White Blight (*Helminthosporium turcicum*). At both centres a series of single and double crosses between inbred lines in the F_6 generation are being tested out this season against mass selected farm seed in the hope of securing combinations of value.

A preliminary test of a few double crosses was made at Njoro in 1936, but the results were unfortunately masked by the high fertility of the land, due to an application of cattle manure. The control maize yielded at the rate of 25 bags per acre, which may be considered a maximum yield under Njoro conditions, and the double crosses showed a big variation in yield, the best of them equalling the control maize.

The inbred material is now becoming fixed in type. A series of early maturing lines are, however, being maintained with difficulty, due to loss of vigour. At Kitale, lines resistant to white blight have been obtained, but resistance to Fusarium has not yet been demonstrated. Selection for Fusarium resistance is hindered by the fact that the only criterion is the infection of the ripe cob; but the plants in use must be marked and selfed at an early stage in their growth. The bottle method of pollinating has proved satisfactory at both centres.

Selection work as a means of improving, and maintaining the improvement, in a heterogeneous crop like maize, whilst more limited in its scope than inbreeding followed by cross fertilization between selected lines, has shown itself to be of great value. Growers have been advised as to the lines on which selection should be practised, and an opportunity has been offered them of testing their seed by means of the seed maize competitions conducted annually by the Royal Agricultural and Horticultural Society of Kenya in conjunction with the Department of Agriculture. Differences in yield of ten to twenty per cent are common, whilst the difference between the highest and lowest yields is often considerably higher. Selection must, of course, be carried out annually, and the fact that certain growers habitually head the competition shows that this point is appreciated and that selection on the lines advocated is of value.

As the result of work carried out on native maize in the Central Province, a type known as Muratha, which is white in colour, matures earlier and yields better, has been built up by selection. The ordinary flat white maize of the country is too slow in maturing to suit the conditions prevalent in the Kikuyu country, and Muratha maize supplies the early maturity required in this connexion. Attention is now being given to improving the disease resistance of this maize.

R. J. L.

Preliminary Studies on Grasses and Grazing made at Ngetta, Northern Province, Uganda

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At Ngetta, four miles north of Lira, is a farm financed by the Lango District Native Administration for the purpose of investigating agricultural problems relevant to Lango. The elevation of the farm is 3,700 feet, and records for the past eleven years show an average annual rainfall of 56.21 inches. Less than 1.5 inches falls during each of the months of December, January and February in an average year, and November is usually rather dry. About 49 inches of rain is fairly evenly distributed between the beginning of March and end of October, although one, or sometimes two, dry spells of up to three or four weeks' duration may occur within this period. May (9.5 in.) and August (8.23 in.) have the highest averages. The mean maximum temperature varies from 92.2 in February to 81.3 in July, and the minimum from 64.6 in April to 60.0 in December. The soil is a brown, rather sandy, friable loam which dries out rapidly during dry spells. The natural vegetation in the locality may be described as high-grass low-tree savanna, the dominant species being fire-resistant Grewias, Bauhinias, Combretums, Sapotaceae, Terminalia and Acacia species. The grass under natural conditions consists largely of an almost pure stand of *Hyparrhenia filipendula,* although after burning in the dry season *Imperia cylindrica* becomes dominant for a short period.

Present Objects of Grass Work at Ngetta

Lack of information concerning grasses growing under conditions similar to those obtaining in the Northern Province of Uganda necessitated the work at Ngetta commencing *de novo*. Up to the present, it may be said to fall into two main divisions:—

(*a*) Initial observations on a collection of all local grasses (plus a few imported species) grown as pure stands in small plots.

(*b*) The utilization of the information obtained from (*a*) to evolve a temporary ley suitable from the point of view of grazing capacity and soil regeneration for the three-year resting period which occurs in the local arable rotation. This of course involves work to ascertain the best means of establishing a ley, and calls for observations on the effect of grazing, controlled in various ways, but it is hoped that much other useful information on grasses and their habits under the particular conditions will be obtained.

(*a*) *Initial Observations*

In 1931 observation plots containing pure stands of all the local grasses were planted, and the collection was increased from time to time by importations from other parts of Uganda and from Kenya. Many grasses soon proved to be of little value under Ngetta conditions and were not persevered with.

The following is a list of the species planted, together with a summary of the notes made on them whilst in the observation plots:—

Panicum fulgens.—Discarded after one year as being of no value.

P. maximum.—This grass produced a good bulk and further trials were initiated to test its grazing value.

P. trichocladum.—This did not thrive owing to heavy infestations of rust.

P. atrosanguineum.—This proved to be of no value.

Digitaria uniglumis.—This produced little bulk, but further investigations were considered advisable.

D. scalarum.—A swamp grass of little value on dry areas.

Eragrostis major.—Produced little vegetation.

E. aspera.—Similar to *E. major.*

Sporobolus pyramidalis.—This grass warranted further trials under field conditions.

Brachiaria decumbens.—This can only be satisfactorily established from cuttings. It produces a good amount of fodder and stands up well to the dry season.

Brachiaria kotschyana.—This annual did well under local conditions and produced a fair amount of fodder.

Eleusine indica.—An annual of little value.

Cynodon Dactylon.—This can be readily established from cuttings and rapidly forms a soil cover.

Cynodon plectostachyum.—Similar to *C. Dactylon,* but more robust.

Setaria sphacelata.—Although an indigenous grass this was rather difficult to establish, the seed having a low viability, and cuttings grew slowly in the early stages.

Pennisetum polystachyon.—This grass can be established from seed. It grows rapidly, but only persists for about two years.

P. clandestinum.—Several attempts were made to establish this grass, but without any success.

P. unisetum.—Grew well during the rains, but tended to die out during the dry season.

Hyparrhenia filipendula.—Can be easily established from cuttings, and produced a good bulk of vegetation.

H. rufa.—Does not appear to be of any value.

Paspalum notatum.—Has been introduced recently. It promises well.

Melinis minutiflora.—A recent introduction which is doing very well.

Chloris gayana (Australian Strain).—This did very well in the early stage, but during the last dry season suffered severely.

Chloris gayana (Local).—This is easily established from either seed or cuttings. Undoubtedly a most promising grass.

Indigofera endecaphylla.—Easily propagated from seed. It establishes a good bottom herbage, but little bulk.

Medicago sativa.—After extensive trials this has proved to be of little value under local conditions.

(*b*) *Subsequent Work: Attempts to form Suitable Temporary Leys; General Observations after Establishment, including Grazing Notes and Records*

All work on the above has to be arranged so as to fit in with the general farm programme. Experiments and trials are carried out with various crops, but there are two main rotations which must be followed. Included in these is a three-year resting period under grass, and it is on this resting land that most of the work on grasses is done. There are no permanent grazing areas except two small swamp paddocks that supply valuable additional grazing during the dry season.

Seed Supply.—One of the chief difficulties in connexion with grass work at Ngetta is to obtain an adequate supply of the grass seed required. The collection is rather costly and the viability of seed from some of the better grasses is low. It has been found that the following pasture plants are the most easily established from seed: *Chloris gayana* (both Australian and local strain), *Pennisetum polystachyon, Sporobolus pyramidalis, Medicago sativa,* and *Indigofera endecaphylla.*

An attempt is being made to raise selections of the better grasses with a higher percentage of viable seed. The preliminary results obtained by raising succeeding generations from grasses which grew from seed have been promising.

Method of Sowing and Establishing.—The best results have been obtained by ploughing as early in the year as possible and then allowing the soil to weather until May. The land is then weeded by hand hoe and the seed sown broadcast on

the still rather rough surface. A harrowing with a spike harrow is then given. This suffices to cover the seed, but does not fill up the depressions left after ploughing, which at Ngetta have proved to be very successful in arresting erosion and in effecting an even stand of plants.

During the first two months after the seed is sown, the vegetation on the plot consists largely of weeds. It is not, however, considered advisable, or at any rate necessary, to weed, as the grasses soon become dominant. Weeding during these early stages has been carried out, but was found not only to be of no advantage, but possibly harmful in that numbers of young grass plants were likely to be destroyed.

Various sowing dates have been tried, but under the local conditions May is found to be the best month. Later sowings failed to become thoroughly established before the dry season set in.

Attempts to form Pastures and Leys, (i) *With Pure Stands,* (ii) *With Mixtures*

(i) The first attempt to form a pasture was made by planting up a six-acre block with sets of *P. maximum.* This grew well and produced a good bulk of fodder, well liked by stock. It failed to form a sward, however, in spite of controlling the grazing in various ways, and there was soil wash between the tufts or hummocks.

Later, another plot was planted with *Pennisetum polystachyon,* but this failed, as did also an attempt to establish a plot of lucerne. The lucerne plot was eventually covered with an almost pure stand of *Cynodon Dactylon.*

A three-acre block was then divided into ten plots, and one of the following planted on each: *Brachiaria decumbens, Indigofera endecaphylla, Cynodon Dactylon, Pennisetum polystachyon, Pennisetum unisetum, Setaria sphacelata, Medicago sativa, Panicum trichocladum, Panicum maximum,* and *Sporobolus pyramidalis.* These plots were under observation for three years, various notes being made during that period, including some on the relative palatability. Records of the grazing capacity of this block of plots kept during the third year of its existence showed the remarkable figure of an average of 1.96 ox-days grazing per day.

Setaria sphacelata was easily the best, forming a good soil cover, giving plenty of palatable food, and standing up very well to the dry season. (Later a pasture of this grass was heavily infested with ergot, but it is not yet known whether this is common on this grass under local conditions.)

Brachiaria decumbens was also successful; it formed a good soil cover and plenty of fodder, but did not appear to be very palatable.

Indigofera endecaphylla formed a good soil cover but little fodder.

Cynodon Dactylon was readily established and spread to adjoining plots, but was not readily eaten by stock when other grasses were available.

Pennisetum polystachyon and *P. unisetum* dried out. The former produced a good bulk for two years (not liked by stock), but the latter was never well established.

P. maximum.—Large amount of fodder liked by stock, but never gave complete soil cover. It was hummocky throughout in spite of heavy grazing.

P. trichocladum was heavily infested with rust, and under Ngetta conditions appears to be of little value.

Sporobolus pyramidalis was very slow in becoming established, and did not appear to be relished by stock.

(ii) *Mixtures.*—The first mixture to be tried on a six-acre block was the following:—

	Per acre.
Pennisetum polystachyon	3 lb.
Panicum maximum	2 lb.
Brachiaria decumbens	4 lb.
Sporobolus pyramidalis	¼ lb.
Pennisetum unisetum	2 lb.
Setaria sphacelata	5 lb.
Indigofera endecaphylla	¼ lb.
	16½ lb.

This formed a fairly good pasture, but a heavier seed rate would have given better results. A remarkably good supply of food was, however, produced, and grazing records kept over a period of eighteen months show that a year after sowing the pasture was capable of supporting in good condition 1.5 oxen per acre, whilst during periods of good rainfall 2.5 oxen per acre were maintained on this area. It is of interest to add that when this block was due to be ploughed up after the three years under this mixture, all of the grasses sown were represented except *P. polystachyon* and *P. unisetum*.

The best mixture so far established was sown in 1936. It was:—

	Per acre.
Pennisetum polystachyon ..	18 lb.
Setaria sphacelata	17 lb.
Brachiaria decumbens	6 lb.
Setaria aurea	3 lb.
Hyparrhenia filipendula ..	12 lb.
Hyparrhenia sp.	5 lb.
Panicum maximum	1 lb.
	62 lb.

The seed rate was heavier than was intended, owing to a misunderstanding. This shows considerable promise, but it is too early for further comments to be made now.

Time to Commence Grazing

Difficulty has been experienced in deciding when the pastures are sufficiently established to permit grazing without impairing the chances of the grasses surviving the first dry season. Too early grazing has proved to be harmful, whilst allowing the grasses to grow for about six months seems to favour the establishment of the more vigorous grasses to the detriment of the slower growing and shorter species. No definite conclusions have yet been reached, but tests to compare close grazing versus allowing a fair cover to be maintained have undoubtedly been in favour of the latter practice.

The work at Ngetta is carried out single-handed by a succession of Agricultural Officers making observations between periods of district and other work.

For this reason progress is not rapid and few, if any, conclusions can yet be reached. There is so much to be confirmed and so much more to be done. The important question whether a three-year resting period under grass will maintain an adequate standard of fertility has not been answered, but results to date show that some of the heaviest yields of crops on the farm have been obtained on plots which have been down to grass for that period and grazed, no additional manure being applied during the arable period. An experiment is now being conducted to compare the residual value of various grasses at the end of the three-year period, when both grazed and ungrazed. Other observations, such as succession after cultivation (noting how this varies according to the last crop grown), and the effect of grazing controlled in various ways, are being made, all of which it is thought will play an important part in enabling and encouraging cultivators to have that which, if not at present a necessity in the Northern Province, is certainly desirable —a holding which can be permanently as well as profitably cultivated.

Review

THE USEFUL PLANTS OF WEST TROPICAL AFRICA, J. M. Dalziel, pp. xi, 612; The Crown Agents for the Colonies, 1937; 18/-.

This volume, published under authority of the Secretary of State for the Colonies, carries the sub-title "An Appendix to the Flora of West Tropical Africa," but to many people it will be by no means the least important section of that great work. It crowns a notable achievement of scientific publication, not the only one of its kind that the British West African Colonies have to their credit, and it provides once again an example of inter-territorial co-operation that in this field the East African territories have been slow to imitate.

The author is peculiarly well fitted for the task of preparing this volume by his botanical knowledge—he is a part author of the whole flora—by the fact that he is a medical man, and, not least, by his personal West African experience. From the East African point of view the value of the volume is enormously enhanced by the fact that many of the West African genera and species occur also in East Africa, and that Dr. Dalziel has treated this subject broadly, including for such plants East African as well as West African information. To quote the author, in this book a record has been compiled of some of the native plants in common use —domestic, commercial, medicinal, etc.— among the people themselves, with indications in certain cases of their possible value in other directions. The known and suggested applications of most of the exportable indigenous products of West Africa are outlined, but such commercial exotics as cacao and para rubber are not included.

Dr. Dalziel's field notes, some of which date back to 1905, have formed a nucleus, and he has, with the aid of the multitude of useful notes and native names accompanying the botanical specimens in the Kew Herbarium, and recorded also in past or current literature, got together a mass of valuable and interesting information.

To take a random example, the author's notes on cassava (*Manihot utilissima* Pohl.) occupy four closely printed pages. The English names of the plant are given, followed by the vernacular names employed in the different West African countries; geographical distribution with economic notes; varieties, with special reference to palatability and poisonous properties; analyses; methods of preparation and uses for food and other purposes. Finally one learns that "medicinally the scraped pulp makes a good poultice as a substitute for linseed meal; it is also put on burns, foul ulcers, jigger sores, etc. In fever and headache pounded leaves are applied as a compress to the head." All the information is supported by detailed references.

Again, the baobab receives three pages of treatment. None of its products appears in world commerce, but the variety of native uses for every part of the tree is astounding. Apart from the vast number of medical applications, which one is, as usual, inclined to take as owing more to faith than to efficacy, the tree seems to minister in some degree to every human want, from tanning materials, wall plaster and soap to cordage, snuff and rubber-coagulant. The fact that, in East Africa at any rate, the hollow trunk often provides a lair for peculiar and poisonous little *sheitani* is perhaps outside the scope of the author's work.

An appendix of this nature is a new departure in connexion with the publication of a Flora, and it furnishes a most useful link between botanical knowledge and research and the work of all those who are engaged in the administration, welfare and economic development of a region. Moreover, it is provided with good indexes of common and of generic names. As so many of the plants referred to extend across the continent, the book is heartily recommended to those interested in agriculture, forestry, medical practice, and commerce in East Africa.

Artificial Drying of Pyrethrum

Pyrethrum is becoming more and more important as a crop, not only in East Africa but elsewhere. When only small plots or, at the best, small fields were cultivated, sun or shade drying was possible but, as the individual grower increased his area under pyrethrum such methods become impossible. The area needed for sun drying rivals in size that under cultivation, sheds to protect the drying flowers become enormous. The only logical method is artificial drying by hot air. The information regarding the effect of heat upon pyrethrins is very meagre.

In Kenya, where individual growers may have as much as 150 acres under pyrethrum, the need for fuller information was acute, temperatures varying from 100° Fahr. to 150° Fahr. were being used in drying houses. Beckley and McNaughtan found that drying flowers at a temperature of 140° Fahr. caused a slight but appreciable loss in pyrethrin content and recommended that the temperature should not exceed 130° Fahr. (this *Journal*, Vol. II, pp. 327-338).

Similar conclusions have been reached by Jary, Martin and Tattersfield (*Journal S.E. Agric. Coll.* Wye 1937, No. 40, pp. 108-114). Using a model experimental hop kiln, in which the temperature could be carefully regulated, and very carefully picked flowers, they found a very distinct loss of pyrethrins in flowers dried at temperatures above 140° Fahr. They consider that temperatures up to 140° Fahr. would be comparatively safe for drying pyrethrum flowers in a kiln. Commenting on the conclusions of the local workers they state: "Our experiments would indicate that this temperature, 129°-131° Fahr. is near an optimum for purposes of drying pyrethrum flowers and if it errs at all it does so on the safe side."

They also found that flowers dried at 113° Fahr., taking 21 hours as against 10 hours when dried at 126° Fahr., had suffered a very slight but probably significant loss of pyrethrins. This loss cannot be ascribed to the temperature as there was no loss in flowers dried more quickly at temperatures of 126° and 140° Fahr.

Under commercial conditions, where very large quantities must be dealt with, a time of drying of 24 hours is common, so that it is possible that there may have been a slight loss in pyrethrin content. As there are driers now in use which are capable of drying flowers in 8 to 12 hours, it appears that their adoption will not only prove more economical but will give a slight rise in pyrethrin content.

V. A. B.

Romney Marsh Sheep in the High-Altitude Areas of Kenya

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The sheep industry in these areas developed originally with almost exclusively low-grade Merino stock, and it was later proved that under these high-altitude, heavy rainfall conditions, with frequently an exceptionally strong growth of grass, the Merino did not flourish. Mortality amongst lambs was very heavy, considerable trouble was experienced with feet, and lambing percentages were low. The farmers were quick to appreciate the position, and decided to change over, using Romney Marsh or Kent rams, with the result that at the present time this breed predominates in these areas, although much of the female stock still contains Merino blood.

It is important to remember that wool has proved the most profitable part of the enterprise under these conditions, and the meat policy has consisted largely of the production of fat wethers for sale on the local markets. These are usually sold before they have got two teeth and when a profitable wool clip has already been obtained. There is an increasing demand for slaughter stock from these areas to supply the local market. Romney wethers are wanted by butchers who have hitherto purchased the bulk of their requirements from the Merino areas. The Romney at 110 lb. live weight yields an exceptionally good carcass, well fleshed, with a good saddle and useful shoulder, and is therefore exceedingly popular as a butcher's beast. Farms as a general rule in these areas are not fully stocked, and therefore the problem of the disposal of draft ewes and inability to carry large numbers of wethers up to slaughter weights has not as yet arisen. It is, however, probable that in the near future old draft ewes will be sold off such farms to be used as flying, i.e. temporary, flocks in the low-altitude arable areas, and also that at least some of the ewes will be served by a ram of mutton breed for the production of fat lamb carcasses, which will attain slaughter weights before the lambs are weaned, and will not require to be run on until they have attained slaughter weights.

Sheep are playing an increasingly important part in the farming system in these areas, since they thrive exceedingly well on arable land which has either been grassed down artificially or has naturally reverted. They quickly spread indigenous clover and Kikuyu grass, although the latter may be a distinct danger on arable land which it is intended to replough after a few years' rest, on account of the difficulty of eradication. They eat a very large number of weeds, and the mechanical treading of the feet probably has a distinctly beneficial effect on the soil and herbage. In addition they add a considerable amount of humus to the land. The future of arable farming in these areas probably lies largely in the use of a system of alternate husbandry in which the sheep will play an increasingly important part.

PARASITES

Control of internal parasites is one of the most essential factors in successful sheep husbandry. The use of arable land in rotation for the flock assists in this respect. While full information is obtainable from the Veterinary Laboratory about parasites, yet the experience of a successful flockmaster in their control will be useful. There are only three types of dosing which have hitherto proved necessary in these areas, and they are briefly as follows:—

Wireworm remedy is supplied by the Veterinary Laboratory with full directions. Dosing is carried out monthly, except in the height of the dry season, and one double dosing is given once or preferably twice a year.

Carbon tetrachloride controls hookworm and fluke; a maximum of 3 c.c., mixed with 4 c.c. of a light lubricating oil, is injected into the cheek portion of the mouth of the sheep—a simple and quick procedure. The head of the sheep should be left free during the injection. Tetrachloride is, however, a dangerous drug and its use not always thoroughly understood, and a heavy mortality can result if it is not administered carefully. It is always wise to dose a few weak sheep on the day before the main flock, in order to be certain that no harm will result. Tetrachloride is administered usually twice yearly, when the grass is green.

The only other worm that causes trouble in the sheep is tapeworm, which infects lambs. Wireworm remedy and nicotine are not satisfactory, but Cooper's Dip and salt appear very efficacious.

In these high-altitude areas, fluke may be a distinct menace, and sheep should never be herded near swampy, reedy places, where fluke abound.

In addition, there are two external parasites, sheep scab and sheep keds, the control of which necessitates a dip. The requirements for a dip can be met by the small metal tank supplied by Cooper's, or by a stone circular dip of the correct pattern, which costs less than £15.

Sheep scab can be eradicated by dipping in lime sulphur, either mixed on the farm or made from a proprietary article. It is important to dip the posts and wire-netting of the fold as well, and the sheep should be kept out on open pasture for ten days after each dipping, so that the scab cannot remain on bushes or trees and reinfect the stock. The parasite is easily controlled in the high altitudes, but if the control measures described above are not observed it can cause very severe damage both by affecting the wool clip and debilitating the sheep.

Sheep keds were presumably imported into Kenya comparatively recently on pure-bred stock. They cause irritation to the sheep, stain the wool, and are serious in lambs because they leave the ewes in preference for the lambs, and in severe infestations it is not uncommon to find over a hundred on a small lamb. The eradication of keds is performed by double dipping in Cooper's Dip.

Diseases

There are not many diseases of sheep that are likely to cause inconvenience in these areas, but four are noteworthy.

Heartwater.—This can be avoided by the removal of all squatter stock, after which the ticks are cleared up by dipping cattle. The heartwater tick does not travel up higher than the sheep's belly, so that it can be controlled by shallow dipping.

Blue Tongue.—This disease seldom appears, but if it does it can be controlled by inoculation and the removal of sheep-folds to the highest ground available.

Foot Rot.—This is present generally on most farms, particularly during the heavy rains. The first symptoms are a redness in the cleft of the hoof, followed by heat in the hoof, and finally the whole hoof becomes badly infected. Feet should be kept in shape by careful trimming throughout the season, but this in itself will not prevent foot rot. A foot-bath, about 10 ft. long, should be made of cedar, 8 in. wide at the bottom, 10 in. at the top, and 8 in. high. In this is put a ten per cent solution of copper sulphate, hurdles being placed on each side. The sheep are walked through this once or twice weekly if necessary, care being

taken not to splash the wool. In some cases they are made to walk over a small area containing lime as they leave the foot-bath. In very severe cases the knife should be used drastically and a mixture of Stockholm tar and bluestone powder (the tar containing as much bluestone as possible) is rubbed in.

It is of vital importance to maintain the feet of the sheep in good condition, since inability to walk without difficulty will restrict their grazing and they will lose condition. For in-lamb ewes failure to treat the feet properly may be disastrous.

Lamb Dysentery.—This can be a serious disease. The in-lamb ewes can be inoculated as a preventative. Continual moving of the sheep is necessary in the event of an outbreak.

General Management and Husbandry

In order to justify a shepherd, a minimum of fifty ewes is desirable as the foundation of a flock. In most cases it pays to purchase old ewes, since they will thrive on land clean of worm infestations which has not previously carried sheep, and also there is always the possibility of tick-borne disease. The initial outlay of much capital is not justified until the farm is proved as being safe. Attention should be paid to the mouths of such old ewes, which, provided they have no missing teeth (broken mouths), will probably have a considerably prolonged life on clean land, particularly where use can be made of old arable lands. There exists some difference of opinion as to whether such ewes should be purchased in-lamb or empty. If purchased in-lamb there is the certainty that all will breed. Frequently, however, it is possible to purchase cheaply old ewes which have missed a lambing through failure to take the ram or some other cause, and while it might be supposed that such would subsequently be shy breeders, this is often by no means always so. The long rest that has been afforded to the ewes in this manner often affects them favourably, and an instance is recorded where ten such ewes, when tupped with a ram of Down breed, reared successfully fourteen lambs, none failing to breed and several of course rearing twins. It is important to remember in the management of sheep that frequent movements are necessary, and therefore all folds, shepherd's hut, troughs, etc., should be easily movable. The shepherd's hut should be in the form of a sledge, and the fold itself constructed of pointed stakes and surrounded with four-foot wire netting, 4 in. mesh. It should be moved if possible every three or four days, depending on the weather. In addition, there should be a trough containing a salt, bone-meal and lime mixture, which should be before the sheep always and not fed at weekly intervals. It is important to remember that, when sheep are being herded on reverted arable land which it is intended to replough, frequent movements of folds and feeding troughs are necessary, otherwise the crops will be patchy when the land is reploughed, owing to the heavy concentration of the flocks in certain areas. This patchiness is caused by the excessive deposition of dung where the animals have been allowed to concentrate, and is likely to cause "laid" crops subsequently.

The choice of grazing for sheep is very important, in particular for weaning lambs, which should always be weaned to rising keep, i.e. grazing that is improving in condition. For this purpose reverted arable lands are probably the most suitable, or alternatively wheat, barley or oat stubbles on which there is a certain amount of volunteer crop. Sheep definitely prefer volunteer barley or oats to wheat. After the first rains, care should be exercised on these stubbles, as the

sheep are liable to pick up an excessive quantity of swollen grain and mortality may result.

In veld grazing, cattle should always if possible precede sheep, for which they improve the grazing, provided it is adequately rested. Long matted grass should be avoided, and also land that has been recently burnt. The seeds of red oat grass can cause considerable trouble by penetrating in the flesh of the sheep.

Kikuyu grass is an ideal feed for sheep, except where it tends to grow excessively lush, as on the forest soils at Elburgon or at Limuru, where the humus content of the land is very high. Under these conditions frequent trouble occurs from blowing and also various digestive disorders which may lead to a considerable mortality, but when growing on the open land, as at Molo, the grass has proved itself excellent. As mentioned previously, sheep tend to spread it freely about the fallows and presumably the seed is partially digested in their bodies and therefore germinates readily when excreted. If it is desired to allow an arable field to revert to Kikuyu grass it is best to do so after a crop of oats or barley in preference to wheat. It is important to control the reversion of the land by adequate mowing so as to prevent the incursion of weeds such as "forget-me-not," whose seeds may penetrate into the wool of the sheep. Usually under these conditions a varying percentage of blue couch (*Digitaria* sp.) becomes established in the land, and this also is a useful feed for sheep. It is important to control the coarse tuft grass (*Eleusine Jaegeri*) which frequently comes in on such reverted lands. This can only be done satisfactorily by removal by hand.

Water is a very important problem, particularly in the dry season. The streams in the high-altitude areas are usually a source of fluke. Clean fresh water is essential, and water piped from a spring into permanent stone troughs is ideal and quite cheap. Some flockmasters avoid using dam water for their sheep on account of the risk of disease, although others have to use it perforce when other supplies are not available.

Selection of Rams

It is important to remember that there are two types of Romney in Kenya, viz. the English Kent type and the New Zealand. The New Zealand is woolled right down and more heavily, whereas the English Kent is essentially a mutton type carrying less wool, but usually with a larger frame, and probably the use of the English rams leads to the production of an ideal slaughter wether. At the same time, since wool is the most valuable source of income from sheep, it is important to select any ram to a large extent on wool characters. He should carry plenty of wool, not too coarse, free from kemp and well down his hind legs. The choice of the English or New Zealand type will also depend on the character of the ewes. If the ewes are of the Merino type with small bodies and small frames, then there will be a tendency to use the English type; but, if the ewes are already large and well framed, to use the New Zealand rams. Whichever policy is adopted, however, it is important that it should be consistent; many of the earlier mistakes in sheep husbandry in Kenya have been due to frequent changes of type of rams and sources from which the rams were obtained. It may even be desirable that line breeding should be practised. Where valuable imported rams are being used, it is advisable to hand serve. This is performed by using ordinary grade rams fitted with aprons as teasers to detect the ewes on heat. Each ewe is driven into the pen where the stud ram is housed; he

is allowed to serve her once and she is removed. If the ewe fails to hold at this service, when she returns she is tupped with a flock ram. In this manner many more ewes can be covered with the selected rams, commonly three or four times the usual number of fifty where ordinary methods are used. In addition, artificial insemination offers distinct possibilities (this Journal, Vol. III, pp. 120-128).

Lambing

Under present systems of husbandry, twins are not an advantage, since the ewes will frequently not have enough milk for them, but as increasing use is made of old arable lands and it becomes possible to feed silage in small quantities to suckling ewes, flockmasters will cease to be content with a fall of 85 or 90 per cent. It has been shown that the ordinary Romney ewe in this country is easily capable of rearing twins, provided adequate feeding on the lines described above is available, and it will therefore be necessary to pay more attention to such operations as flushing and possibly to the use of rams who are themselves twins. It is often regarded as a fallacy that this character can have any effect on twin production, but such little evidence as is available tends to show that it may.

Flushing can be best performed by removing the ewe flock from poor or indifferent grazing to really good keep about ten days before they go to the ram. Thus, if they had been on veld grazing, they could be run for an hour daily on a young crop of oats or volunteer cereal, taking care to avoid blowing at first. The Romney gives little trouble in lambing, but it is good plan to have two folds near at hand, one for in-lamb ewes and the other for those that have already lambed.

Shearing

This is best carried out before Christmas, so that the wool will be sold on the March sales. It has become a simple process since many trained shearers are available. Lambs should be shorn at six months and should yield about 2¾ lb. of wool, ewes over 6 lb. Shearing can be done twice yearly in the event of keds or scab, since the lower values obtained for the shorter staple wool are more than offset by the higher total weights obtained. With a small flock the wool should be graded into as few grades as possible, and no very elaborate classing attempted.

Future Mutton Policy

While at the present time there is a ready local sale for all wethers with two teeth, scaling about 115 lb., the future must be considered when farms are stocked up and local markets saturated. Pure-bred Romneys do not make good fat lambs; they are difficult to finish at early ages owing to their tendency to grow large frames, and for this reason the use of rams of mutton breeds may become necessary for fat lamb production. Experiments are proceeding with the use of rams of Down breeds on such ewes, and it is hoped that eventually an export trade will be established.

SUMMARY

The capital outlay required on sheep is not great, particularly expenditure on buildings, etc., nor do they entail a large amount of European supervision. Apart from such operations as dosing and dipping, they usually receive attention at hours in the day when work with other live stock is in abeyance. They should provide a monthly cheque from sale of slaughter stock in addition to the large annual return from wool. The future of arable farming in these areas will depend in large measure on the use of sheep in the rotation as a means of yielding a return from areas allowed to revert to grazing.

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History and Trend of Experimental Work on Arabica Coffee in the Bugishu District of Uganda Protectorate

By ANDREW J. KERR, *M.A. (Cantab.), A.I.C.T.A., Agricultural Officer, Department of Agriculture, Uganda Protectorate*

INTRODUCTION

In the fertile valleys and on the lower slopes of Mount Elgon, westwards of the Kenya-Uganda boundary, an Arabica coffee industry of recent development flourishes. Thirty years ago Arabica coffee was unknown there, but by the end of 1936 over six thousand acres had been planted.

OUTLINE OF DEVELOPMENT

The development can be roughly classified into three periods, the first being prior to 1921, the second between 1921 and 1929, and the third from 1930 onwards.

(*a*) During the first period, the satisfactory growth of a few trees of Arabica coffee which had been introduced into Bugishu Distrrict soon after the administration of Uganda Protectorate was taken over by the Colonial Office led, apparently, to the first free distribution of coffee seedlings to natives in 1912. In 1913 there were about three acres of coffee in bearing, and in 1915 the crop amounted to 11 tons. Instruction was given to growers in the preparation of their crop for sale, including pulping, fermenting and drying, but it was some years before they realized its value, for the sale of small quantities of native prepared parchment was difficult and the demand for labour on estates, both in Uganda and Kenya, provided a ready source of money with which to pay taxes. By 1921, the end of the first period, the crop was only between 20 and 30 tons of parchment coffee, but the period had at least served to show that Arabica coffee would thrive in certain areas of Bugishu.

(*b*) During the second period, from 1922 to 1929, planting was encouraged. In 1922 twelve nurseries were established in South Bugishu, and the first hand-pulper was installed, whilst in 1924 demonstration-observation plots were established at about twenty scattered centres from a nursery in North Bugishu, near what was then Bumadibira Camp.

Towards the end of this period several cultural difficulties became apparent. Single stem pruning had hitherto been advocated, but in practice there had been serious drawbacks.

Although trained native agricultural instructors demonstrated the correct method, it proved too complicated for peasant growers, and at the lower elevations, with bad pruning and overbearing, dieback resulted.

(*c*) The third period of development dates from 1930, by which time the crop had reached the figure of about 260 tons parchment. The Protectorate Coffee Officer had made periodic visits to Bugishu, but the Agricultural Officer had till now to supervise work in three districts. When in 1930 a whole-time Agricultural Officer was posted to Bugishu, one of the first steps taken in connexion with the increasingly popular coffee crop was the rigorous control of planting. A nursery system, comprising central nurseries whence seedlings were transplanted to village nurseries prior to distribution to selected growers, was evolved, and since 1932 over a million seedlings have been distributed annually, the crop now being in the region of 2,000 tons parchment annually.

Early Trials

It was not until the second stage of development, when the industry showed signs of expanding, that experimental work was commenced. The little coffee already planted by natives had been established under heterogeneous conditions, especially of altitude, soil and climate.

Owing to the pressure of population, plantains, which constitute the staple food crop in Bugishu, were frequently established in the comparatively slow-growing coffee. Some coffee was planted under shade, some was unshaded. Thus when the demonstration-observation plots were planted in 1924, one sub-plot was shaded with Albizzia, in the second plantains were established, and the third was left unshaded. Single-stem pruning and 8 ft. x 8 ft. spacing were adopted.

Simultaneously a more elaborate experiment was laid down on a small Native Administration plantation at Bubulu, where the district offices were situated, testing unshaded coffee against coffee shaded with Albizzia spaced at 40 ft. x 40 ft.

Later Experiments

From the beginning, it was indicated that the greatest difficulties were to be encountered at altitudes below 5,500 ft. Bubulu Plantation, situated at about 4,000 ft., represented the lowest range at which Arabica coffee was likely to survive in Bugishu, and the demonstration-observation plots supported these indications. It was partly on this account that Bugusege was selected, at an altitude of about 4,800 ft., as the site for a coffee experiment station, at which a number of replicated experiments on modern lines have since been laid down, with a view to obtaining data directly applicable to the now rapidly expanding native Arabica coffee industry rather than to pursuing long-range research.

Pruning

The unsatisfactory nature of single stem pruning at the lower altitudes in Bugishu led to an experiment being established at Bugusege in 1927 to compare it with the Agobiada and Costa Rican multiple stem systems. After bearing a heavy maiden crop in 1930, the single stem trees in this experiment, and others in the district, suffered severely from dieback.

The increased vegetative growth and repressed bearing exhibited by young trees under the Costa Rican and Agobiada systems indicated that a simple multiple stem type might be preferable under native conditions.

In the meantime a "Uganda" multiple stem type, designed for use by natives, had been evolved. It entails obtaining two uprights at an early stage by topping in the nursery and restricting bearing to the primaries of a cycle of uprights.

It was necessary to test the merits of this "Uganda" multiple stem system and it was also deemed advisable to have information regarding the behaviour of trees allowed natural growth. A direct comparison existed in the 1927 planted pruning experiment between Agobiada and Costa Rican multiple stem, so when the second pruning experiment was established in 1930 "Uganda" multiple stem, Agobiada, and natural growth were the systems included.

In view of the possible adoption of the "Uganda" multiple stem in Bugishu, preliminary tests relative to topping were made in the field and at Bubulu Plantation. Results indicated that the distribution of seedlings topped in the nursery about three months before issue to growers is preferable to the distribution of seedlings topped at the time of issue.

The nursery system previously outlined lends itself to the distribution of young trees trained on the multiple stem system

Were it not for this control there would be difficulty in ensuring that young trees were started in the right way.

Turning now to the yield figures, statistical analysis of the 1927 planted pruning experiment showed that although single stem yielded a significantly heavier crop (with P=.05) in the first season than either of the two multiple stem types, after the second crop had been taken the heavier yields given by Agobiada so outweighed the effect as to make it a significantly better yielder (even with P=.01) than either single stem or Costa Rican multiple stem.

When the yields from the third crop were included, this result was confirmed, and succeeding crops, up to the seventh, have emphasized the inferiority of single stem. The pronounced difference between Agobiada and Costa Rican multiple stem is somewhat lost, however, when cumulative yields are considered, though there have been seasonal differences due to the pruning cycles not corresponding. At the end of the 1935-36 season no deleterious effects were visible due to drastic cutting out in replacing the uprights of either type.

In the 1930 experiment overbearing in the initial stages again caused trouble, trees of natural growth being worst affected.

The two multiple stem types also suffered from dieback, but replacement of uprights when necessary being provided against they are rendered less liable to permanent damage. To the end of the fourth (1935-36) crop, "Uganda" multiple stem gave significantly greater yields than natural growth, which in turn yielded significantly better than Agobiada, but it remains to be seen for how many seasons this order will persist.

In connexion with the pruning experiments, records of cherry—parchment ratio, of parchment—hulled coffee ratio, and percentage "grading out-turn" of hulled coffee have been made. Considerable differences in these three ratios were found between the three pruning systems of the 1927-planted pruning experiment, there being more than 10 per cent between Agobiada and single stem as regards cherry—parchment ratio, whilst the differences in "grading out-turn" between these systems caused an appreciable difference in the value of the crop in favour of single stem, not only in that a higher proportion of the larger sizes gave higher receipts, but also in that coffee from the treatment having the better "grading out-turn" also realized higher prices on account of better quality. A full account of this aspect of the work was contained in a paper prepared for the Kenya Planters' Days, 1935, entitled "Notes on possible relationship between cultural treatment, yields and grading out-turn of Arabica coffee."

In the light of these results, the true economic value of the Agobiada pruning system to the end of the 1935-36 season is less than would appear from a comparison of yield figures in terms of cherry.

Layering and Stumping

In connexion with the possible conversion of single stem trees in the district to "Uganda" multiple stem, "layering" and stumping observations were carried out at Bugusege in 1933-34.

The object of the former was to avoid total loss of crop if possible in effecting the change-over. The trees were notched six to eight inches above ground-level sufficiently to allow of their being bent over on to the next tree in the line, but the method was not successful.

The results of the stumping observations indicated any time between the end of March and early October to be satisfactory for stumping.

Summarizing, from the present trend of these pruning experiments, it is indicated that some simple type of multiple stem pruning which, whilst giving heavier yields than single stem over a period of years does not adversely affect "grading out-turn" or quality, will prove to be the most desirable type of pruning for Bugishu conditions.

Cultural Experiments

The cultivation of small plots on slopes is common in Bugishu, and soil erosion has to be guarded against, especially with a permanent crop such as coffee. In the early stages of development, the native method of cultivation consisted, in effect, of periodic digging in of weed cover, and in the maintenance of soil fertility appeared to have something to recommend it as compared with clean weeding.

The fact that plantains were abundantly grown for food meant that there was a plentiful supply of dry leaves suitable for mulching the small acreage of coffee then in existence. Mulching of plots with banana leaves was therefore encouraged and has since become general practice. With the large increase of coffee acreage in recent years, however, the supply of mulch does not suffice requirements in certain localities. Where this is the case, it is necessary to resort to the mulching of alternate rows only. There are indications that the method of applying banana leaf mulch affects the incidence of Stephanoderes, and since 1935 care has been taken to avoid laying it immediately under the trees.

The first cultural experiment was laid down in 1928 to test the merits of clean weeding and mulching with banana leaves against the native method of digging in weed cover. The carbohydrate—nitrogen ratio theory was to the fore at that time. Under this theory, increasing the C/N ratio at the time of bud formation was considered to throw the plant into a fruiting state, so a cover-cropping treatment, cover planted in October and dug in in March, was included. A further treatment involved permanent cover throughout the year. At first the trees were trained on the single stem system, but when in 1930 the impracticability of this type of pruning under native conditions was realized they were allowed unlimited terminal growth, and in 1936 were stumped for conversion to the multiple stem system.

Because of this change in pruning policy, the experiment was duplicated in 1932, using trees pruned on the "Uganda" multiple stem system. Two further cultural treatments were included, one of which entailed laying split banana stems over the ordinary mulch of banana leaves. This treatment was converted to March-to-October cover crop after the first application had revealed the excessive labour requirements. In the other treatment, *Leucaena glauca* was planted in lines between the rows of coffee in both directions. Where the lines intersected, one upright was allowed to grow up to shade the coffee, the rest being cut back from time to time to give a mulch and to stop wash.

Data obtained from the 1928 and 1932 planted cultural experiments showed that the October-March cover-cropping treatment, designed to increase the C/N ratio at time of bud formation, gave heavy yields equivalent to clean weeding and mulching with banana leaves, whilst with two cover crops a year, planted in March and October, to give a permanent cover, yields were significantly depressed to the level of that produced with weed cover.

Good grading out-turns were given by the October-March treatment, and there were indications that cover-cropping improved liquoring quality.

As a result, an elaborated cultural experiment was established in 1936, also at Bugusege. In its design, those factors, important when introducing a new cultural method to natives, such as the seasonal distribution of labour and the use of local varieties of legumes as covers (with which is bound up cover-crop seed supply and family food requirements), were especially studied.

It was already known that October-March cover-cropping was superior to two covers a year, and in order to obtain indications whether October was the optimum planting time two other treatments, September to February and November to April, were incorporated. It was decided to use a local bean as the cover crop. Under the three treatments already mentioned the cover crop would seed, a fact of advantage from consideration of seed supply and native food requirements, but in order to give an estimate of any deleterious effects of allowing it to seed, a fourth treatment was included, viz. October planted cover crop, dug in whilst still green in November, and clean weeded for remainder of the year.

In view of soil temperature and moisture observations carried out in a similar coffee experiment in Kampala, a fifth treatment was included, having a cover crop planted in October and dug in whilst still green in December, then mulched with banana leaves over the dry season, to conserve both moisture and nitrogen.

On the C/N ratio theory, all five treatments so far enumerated are designed to increase yields, which in practice they appear to do over a short period. How long the effect will last, however, is not known. At the lower altitudes in Bugishu biennial fluctuation in yields, followed, in the heavy bearing years, by severe die-back, is a noticeable feature, and it seemed that better results over a period of years should be obtained by maintaining the trees in a more constant vegetative condition.

It appeared that an annual March-to-October cover crop might depress yields and have the desired effect. It was considered that a treatment in which the cover crop was planted to decrease yields in the heavy bearing years and to increase them in the intervening years should prove of better value still. A sixth treatment was included accordingly.

Spacing Experiments

With the increased use of banana leaf mulch in the district, attention was directed towards a reduction of spacing from the district standard of 8 ft. x 8 ft., to minimize mulch and labour requirements.

In establishing a spacing experiment in 1932, the possibility of changing over to a multiple stem form of pruning was borne in mind. It seemed desirable also to try the effect of very close spacing in Bugishu. As a consequence 8 ft. x 8 ft., 7 ft. x 7 ft., 6 ft. x 6 ft., and 4 ft. x 4 ft. spacings were adopted; and for each there was "Uganda" multiple stem pruning as well as natural growth.

During the first few seasons, close spacings gave yields much superior to wide spacings. From the viewpoint of obtaining higher production from a small unit area these results pointed to the possibilities of close spacing in the initial stages followed later by alternate row stumping.

An experiment was therefore established in 1936 in which the effect of three spacings, 3 ft. x 3 ft., 4 ft. x 3 ft. 9 in., and 5 ft. x 5 ft., combined with both alternate row stumping and alternate row uprooting, is being observed. It has not yet been decided at what stage stumping

or uprooting will take place, as it depends on how the trees fare in the early stages.

Shade Experiments

The 1924 planted demonstration-observation plots, referred to earlier in this paper, indicated that the effect of shade on coffee was important at elevations in Bugishu below 5,500 ft. Coffee under Albizzia shade suffered less from dieback than that which was unshaded, though plantains appeared to have a deleterious effect.

In view of the many factors involved in the use of shade trees, it was decided to investigate the effect of light intensity varying to simulate the seasonal leaf fall of indigenous trees. In 1932 a shade experiment was therefore planted testing five treatments. Three of them were similar in that they entailed the gradual removal of shade over a period of one month, then one month without, followed by a gradual return of shade over a period of one month. In one case the cycle was applied so that the month of no shade corresponded with flowering, whilst in the others the no shade period was arranged to fall one month and two months prior to flowering respectively. The other two treatments were permanent shade and a no shade control.

In the shade treatments, bamboo poles were laid on a framework erected 9 ft. from the ground, but as the "Uganda" multiple stem pruning system was followed, by 1936 those in the shaded plots had become so etiolated that it was deemed advisable to stump all trees in the experiment and maintain them afterwards on the single stem system.

A further effect observed was that shade delayed flowering, which necessitated making an alteration in the shade cycle.

Varietal Work

From the difficulties that have been encountered in growing coffee at the low altitudes, it has been apparent for some years that the strain of Arabica coffee growing in Bugishu, though admirable for the higher altitudes, is not completely satisfactory for the lower elevations where the climate is warmer and drier. At low elevations there is a tendency for the trees to overbear before reaching maturity, and in their weakened state they are prone to dieback and leaf-spot. It was considered that a variety indigenous to a more arid climate might prove more satisfactory, with the result that seed of various types has been obtained and observation rows established in a plot situated a short distance from Bugusege.

Varieties obtained include Harar, Blue Mountain, Kenya Selected Series A, Kent's Arabica, Mocha, San Ramon, and Pedang, of which Harar and Kent's Arabica appear so far to be the most promising.

At various other centres in the district varietal plots have been established for observing the behaviour of new varieties under diverse climatic conditions, but it was not until 1936 that a comprehensive variety trial was laid down at a new coffee experiment plantation in South Bugishu, in the form of a 5 x 5 latin square to compare Harar, Kenya Selected Series A, Kent's Arabica, and Blue Mountain with the local type.

In conclusion, it may be stated that though barely ten years have elapsed since experimental work on modern lines started in Bugishu, the application of results obtained has already proved of great benefit to the district, whilst other investigations promise equally important results.

Farm Fencing—Part II

By L. A. ELMER, *Assistant Agricultural Officer, Department of Agriculture, Kenya Colony*

In deciding on the materials to use, careful note should be made of the breaking strain and length per unit of weight of various wires on the market. In addition to the first cost, consideration should be given to the question of maintenance.

As a guide to the landed cost on the farm in Kenya some particulars of railway rates are given below. Prices of iron fencing materials are not given as they fluctuate a great deal. It would also be misleading to give weights of wooden posts as there may be a difference of 100 per cent between seasoned and unseasoned weights of the same timber. As a guide the following weights of *air dry* timbers, per cubic foot, are given:—

Cedar: 32 to 38 lb. per cubic ft.

Mueri (*Pygeum*): 48 lb. per cubic ft.

Muhugu (*Brachylaena*): 60 lb. per cubic ft.

Brown Olive: 65 to 70 lb. per cubic ft.

For freshly cut timber these weights may be doubled.

It is unnecessary to buy very heavy fence posts so long as the straining posts are big. An average post, 6 in. in diameter by 6 ft. long, will contain nearly $1\frac{1}{4}$ cubic feet and might weight $1\frac{1}{2}$ cwt. if freshly cut, whereas a post the same length 4 in. in diameter, will only be about half the weight. Cedar posts should be a little thicker, but with strong woods like Brown Olive, 4 in. minimum diameter will be sufficient for line posts. They should, of course, be treated with preservative if they are to last twenty-five years or so.

All fence posts should be smooth; a rough post with a lot of splinters on it is unpleasant to handle, wastes preservative and gets alight easily in a grass fire. Contrary to general belief, cedar posts do not catch fire easily if they are smooth. Untreated sap wood in cedar is useless for posts or droppers.

When working out the comparative costs of timber or steel standards the table given below will be a reminder of the essentials.

Material	Wood			Steel		
	Number	Weight	Cost	Number	Weight	Cost
		lb.	*Sh. cts.*		*lb.*	*Sh. cts.*
Fence Posts						
Strainer Posts ..						
Corner Posts ..						
Gate Posts ..						
Stays						
Picket Posts.. ..				(Steel stays are sold with plates)		
Rails						
	Total Weight			Total Weight		
	Railage			Railage		
	Road Transport ..			Road Transport ..		
	Preservative Treatment					
	Total Landed Cost..			Total Landed Cost..		

RAILWAY RATES FOR FENCING MATERIALS

	Class	Mombasa to Nairobi, 330 miles, per ton	Nairobi to Nakuru, 122 miles, per ton
		Sh. cts.	*Sh. cts.*
Fencing Material: Wire, plain and barbed, posts, standards, droppers, struts, strainers, hurdles, strain posts and fittings for above ..	10	32 04	12 77
Fencing Material: Ornamental, including railings, palisades, cast iron or steel and wrought iron fencing	7	65 86	25 76
Fencing posts, wooden, in 7-ton lots and over per short truck, and 14-ton lots and over per bogie truck, loading and unloading by owner	10 less 25%	24 20	9 76

Class 10: Rate 47 cents per 100 lb. per 100 miles.
Class 7: Rate 95 cents per 100 lb. per 100 miles.

Durability.—The comparative strength and lasting qualities of the materials should be considered most carefully. Local timbers may be cheaper, but if in doubt use those recommended by the Forest Department or treat carefully with preservative. The Forest Department states that Cedar, *Muhugu,* or Brown Olive will last ten years without preservative. Almost any exotic or indigenous timber, e.g. eucalyptus, wattle, cypress, will do for fencing if treated.

Where grass grows rankly and fires may burn the posts, it may be necessary to use one of the trade preservatives which claim to make timber almost unburnable, or iron or concrete standards. Very dense heavy woods do not burn easily as a rule. Stone pillars are used in some parts of the world.

The manufacture of reinforced concrete standards entails a lengthy description, beyond the scope of this article, but particulars of their construction can be obtained on application to the Librarian, Department of Agriculture, Nairobi. Owing to the present high cost of iron the reinforcing rods will be dear. The manufacture of concrete posts is within the power of any intelligent and handy man. They should not be placed where vehicles may run into them as they are liable to break. The estimated cost of making these at Nairobi is Sh. 2/50 per 6 ft. post. Good concrete should ring if tapped gently with a hammer.

If iron or steel standards are desired, samples should be obtained first and tested for strength. One firm states that if steel standards are painted with an anti-corrosive paint, say every two years, their life should be prolonged indefinitely. In the coastal areas painting every twelve months is suggested.

Wooden Posts

All timbers should be free from bark; heart wood is preferable. For ordinary purposes posts should be cut square top and bottom and should not deviate more than one inch from the proper length. In England they are often pointed and driven in with a mall, but in East Africa it will generally be found better to dig holes for them. If split the cross section can be from 8 in. by 3 in. to 5 in. by 4 in.

for ordinary posts, if round, 4 in. to 6 in. diameter.

Straining Posts or Strainers.—The whole fence depends on the strainers. They should be sound timbers, 10 in. to 12 in. in diameter; if split from big logs they should not be less than 12 in. by 8 in. in section. The usual length is 7 ft. 6 in., which allows 3 ft. 6 in. in the ground. One method of placing strainers is to sink a 12 in. diameter post from 4 ft. 6 in. to 6 ft. deep in the ground, omitting a stay. This entails less work for the farmer or his workman. The writer has no experience of this method but it is recommended by two settlers. A description of the usual way to set up strainers with footplates, anchors or stays, is given later.

Corner Posts.—8 ft. long, 12 in. in diameter, 4 ft. in the ground.

Gate Posts.—As for corner posts. It is best to have gate posts placed independently and not used as strainers; when fencing leave a gap between strainers of 20 feet to 28 feet for the gateway, afterwards placing gate posts and fixing rails from them to the strainers. A gate post is sometimes knocked over by a vehicle and if it has been used as a strainer a big section of fence comes down.

Stays or Struts.—In a 4 ft. fence these should have a minimum length of 12 feet and be at least 5 inches in diameter at the thin end and 6 inches at the butt end. Poles likely to bend, or rot sooner than the posts, should never be used.

Picket Posts.—These are for retaining the ends of the stays. They should also be of the most durable wood obtainable, 2 ft. 6 in. to 3 ft. long, 4 in. in diameter, with one side flattened to fit well against the ends of stays; they are pointed for driving. Large stones can be substituted for footing stays.

Foot Plates and Anchors.—For foot plates use strong and durable sawn timber 2 in. by 3 in. Allow 30 in. lengths for strainers and 3 ft. to 4 ft. for corners. Old plough and harrow discs are useful also.

Pieces of iron, hard wood logs or rocks which wire can be tied round are used as anchors. (Figs. 1 and 2). A timber anchor is sometimes necessary where animals are liable to cut themselves on a wire cable and it also serves as a stay.

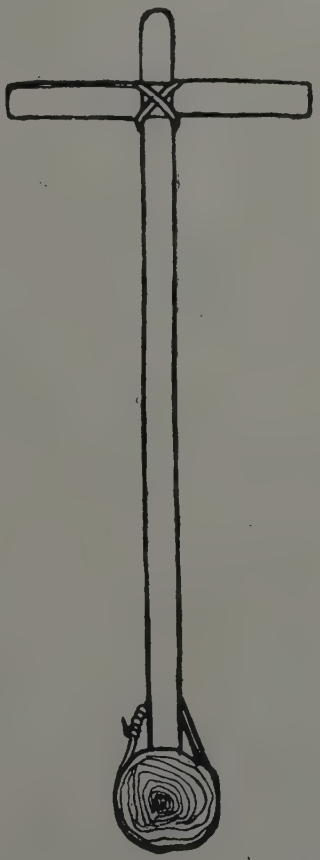


FIG. 1
Combined timber anchor and stay

Droppers.—Droppers are used in order to reduce the number of fence posts. They should not touch the ground or the fence will lose some of its elasticity. In extremely broken country however, strong droppers are sometimes fixed to touch the ground in order to assist the wires to follow smaller rises in the land and thus save an excessive number of fence posts.

Under normal conditions the length of droppers need not be more than three inches greater than the distance between top and bottom wires.

The fencer must decide whether he will use cheap untreated timber and do repairs frequently or whether he will reduce maintenance costs by using sound heart wood, treated wood or steel or wire droppers. Stout wooden droppers are most visible and help to stop game from crashing into the fence, they are preferable to weak metal bars which when bent are apt to hold the wires at a wrong spacing. Strong metal droppers are the best, of course, but are very dear by the time they are landed on the farm. If crimped metal droppers are used it is an advantage to buy shaped wire ties for them.

Wire droppers deserve more attention. They can be made of 6 to 9 gauge malleable steel. The wire is cut to the right lengths and each piece is twisted to the top strand, fastened to the middle wires by a turn or two and twisted again on the bottom strand. Patent metal rings which are bent straight after lacing can be obtained with a special tool for bending them, and are more satisfactory for fixing wire droppers as they allow a thicker wire to be used and there is less tendency to pull the fence wires out of their correct spacing.

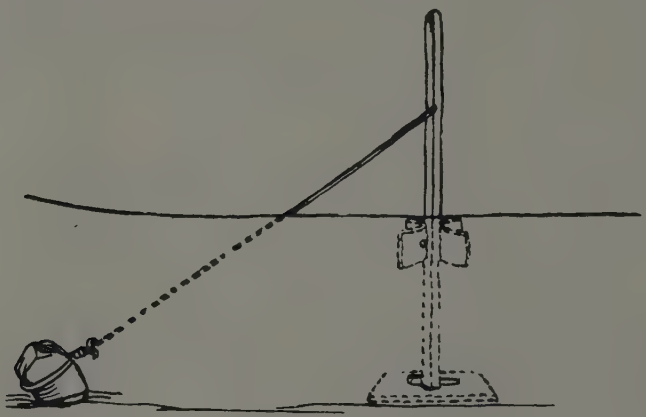


FIG. 2
Iron straining post anchored with wire cable and stone

IRON OR STEEL FENCES

Very comprehensive information about iron fencing materials is obtainable in merchants' catalogues, which are well worth studying. There is a great variety of standards, droppers, netting and woven wire to suit every requirement.

Wire

Plain or Solid Wire.—For temporary work galvanized iron wire is suggested. It is the easiest to handle. It gets slack more easily than steel wire.

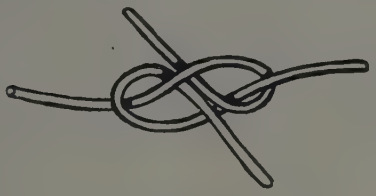


Fig. 3
Knot for joining soft wires

Mild malleable steep wire comes next in order of strength and gives a greater length per unit of weight for the same breaking strain. It is fast taking the place of iron wire.

Hard steel is the lightest and most durable. Once well strained it stands well without getting slack. It is less likely to be stolen than soft wire but it is very difficult to handle. No wire should be allowed to kink, but if steel wire kinks in unreeling it will snap very easily. A broken end can be unpleasant when it whirls round. Hard steel wire is now considered essential on most fencing jobs.

A good test of galvanizing is to wind a wire tightly round a thin rod or a strained wire of its own diameter. If the galvanizing is good the spelter will not flake off or show cracks. Rust will soon destroy a badly galvanized wire.

In an emergency a steel wire can be cut by laying it on a piece of metal such as a hammer head and knocking it smartly with the back edge of a bush-knife until it fractures.

It is often an economy to put a stronger wire on the top of a fence and lighter ones below. If there is a danger of animals cutting themselves on a thin top steel wire, a thick iron wire will cause less damage.

Galvanized Strand Wire.—Strand wire usually consists of seven gavanized wires twisted together to give the requisite size and is often employed as an alternative to solid fencing wire. It is more expensive but gives a greater length per unit of weight, is easier to handle and very durable. It stands being taken down and re-erected better than solid wire and is the best for temporary and movable fences.

The following particulars of solid wires will be found useful:—

Plain Galvanized or Mild Steel Wire

Gauge	Approximate Breaking Strain	Approximate Length per 100 lb.
	lb.	*Yards*
4	2,200	240
5	1,900	280
6	1,620	375
7	1,360	400 to 448*
8	1,125	490 to 541*
9	910	600 to 680*
10	720	760 to 840*
12	475	1,150
13	400	1,473
14	320	1,946
15	240	2,410
16	180	3,030
20	57	100 to 1 lb.

*The greater length refers to mild steel.

Hard Steel Wires

Gauge	Breaking Strain	Length
	lb.	*Yds. per* 100 *lb.*
10 x 12 oval	2,140	930 to 950
11 x 13 oval	1720	1180 to 1200
12½	1350	1360
12 x 14 oval	1120 to 1345	1466 to 1540
		Per 50lb. coil
16	575	1525 yards

It will be noticed that the same gauge of wire sometimes has different strengths and lengths. This is because different

manufacturers do not all turn out the same quality.

A reel should be made for unwinding coils of plain or strand wire on big jobs. In the ordinary way a coil can be placed on a pole or crow-bar and will turn as the end is pulled out.

Barbed Wire.—This is usually made in two-ply or three-ply, which is stronger. In Kenya the use of barbed wire is prohibited in townships except under special permit (Township General Rules under the Township Ordinance, Chapter 82, Part 33, Subsidiary Legislation, Laws of Kenya). In Nairobi it may not be used without a special permit from the Town Clerk (Municipal By-law No. 571). In the United Kingdom barbed wire may not be used on a public highway. This law might be desired in Kenya some day and the possibility should be borne in mind.

Cattle are apt to rub themselves against an unbarbed fence and weaken it, the use of barbed wire prevents this.

Steel wire is more generally used now than iron. It should be remembered that barbed wire will not thread through holes easily. When unrolling barbed steel wire, make use of the swivelled handle supplied in order to allow it to untwist as it is unrolled. It should be unrolled slowly. A pole thrust through the wooden reel is held by two men, or in forked stakes, and as it is paid out the man pulling should be careful to allow it to untwist or it will tie up badly and when cut it will damage anyone near it. It is usually necessary to brake the reel to prevent too rapid paying out. A stake held on the roll will serve or the roll can be held touching the earth.

Barbed wire varies a good deal. There are on the market a number of wires described as 2 by 12½ gauge ply, which it might be supposed would be nearly the same in length and weight. This is not so and care should be taken when ordering. Variations noted for 2 by 1½ ply are:—

Lengths:—

480 yards to 727 yards per 100 lb. with four points every 6 in.

528 yards to 634 yards per 100 lb. with 4 points every 3 in.

Most of these have a breaking strain of about 1,000 lb.

Lighter wires are:—

2 by 13½ ply, four points every 6 in., 774 yards per 100 lb.

2 by 16 gauge, four points every 6 in., 1,350 yards per 100 lb.

2 by 16 gauge, four points every 3 in., 1,100 yards per 100 lb.

Some barbed wires are packed in 50 lb. and some in 100 lb. rolls.

In an emergency it is possible to use a length of steel barbed wire as a two-handled cross cut saw.

Staples.—Fencing staples for wire netting are usually 1 in. by 10 or 12 gauge and ¾ in. by 14 or 15 gauge. For wires the sizes run from 1½ to 2 inches long, by 6, 7 or 8 gauge.

The following table will be of assistance in ordering:—

WEIGHT PER 1,000 STAPLES

Size of Staple	Weight per 1,000 staples	Size of Staple	Weight per 1,000 staples
	lb.		*lb.*
2″ x 6 G	33	1″ x 12 G	5
1¾″ x 7 G	22	¾″ x 13 G	3
1½″ x 8 G	16	¾″ x 14 G	2
1¼″ x 9 G	13	⅝″ x 14 G	1¾
1″ x 10 G	8	⅝″ x 15 G	1¼
1″ x 11 G	6½	½″ x 16 G	¾

Eye Bolts.—Where iron or soft steel wires likely to get slack are used on a permanent fence, eye bolts (Fig. 4) are very useful as wires in position can be tightened up at any time with a spanner.

The usual size is 10 in. or 12 in. long by $\frac{1}{2}$ in. diameter. Before fixing them an extra washer should be added and the threads smeared with stiff graphite grease to preserve them from rust.

FIG. 4
Eye bolt

There are also patent permanent straining attachments for fixing to wood and steel standards.

TOOLS

A satchel or tool case is very useful for smaller things. Tools are apt to be put down hurriedly, walked on and forgotten when moving on to the next straining post.

1. Post hole augurs.
2. Coffee holing tool for cutting roots.
3. Short crowbar for soft rock or murram.
4. Bush-knives, mattocks, hoes, axes, shovels.
5. Stout stakes 8 ft. long, sharpened for ramming dry earth.
6. Patent wire-straining tool or home-made strainer, forked branch or ox yoke and plugs for locking wires in post holes.
7. Brace and bits, $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in, and 1 in. for mortising.
8. Augurs, $\frac{1}{2}$ in. and $\frac{5}{8}$ in.
9. Wire cutters
10. Pliers
11. Pincers

   } or a comprehensive fencing tool

12. Mortising chisel, large size 1 in. to $1\frac{1}{2}$ in.
13. Mallet.
14. Mall.
15. Hammer.
16. Saws, hand and cross cut (small).
17. Key for twisting ends of wire.
18. Reel for unwinding plain wire.

There are interesting fencing tools to be seen in the hardware shops, such as fencing clamps, round pliers, cutting pliers, etc., which are not strictly necessary but will facilitate work on big jobs.

No. 1, *Post hole augurs.*—These are not essential but if the job is a big one it is advisable to have one 6 in. and one 10 in. or 12 in. augur. Natives find it difficult to dig holes with vertical sides and can make very heavy work of it. The augurs are quicker and make smaller holes in which posts stand up better.

No. 14, *Mall.*—This can be made on the farm from a round section of hard wood, the local blacksmith will fit two iron bands to preserve the ends.

No. 17, *Key for knotting and twisting.*—This is a handy little tool with a hole in it to hold the end of a wire while it twists it up neatly. A piece of flat iron about 8 in. by $1\frac{1}{2}$ in. by $\frac{1}{2}$ in. with $\frac{1}{4}$ in. holes at middle and ends will do.

Fig. 5 shows the best type of revolving spindle for unreeling the rolls of plain wire. The base is a piece of wood 6 in. by 4 in. by 2 in. long, slightly tapered at each end. A shaped log would do. The bottom of the frame is two pieces of 3 in. by 2 in. about 4 in. long

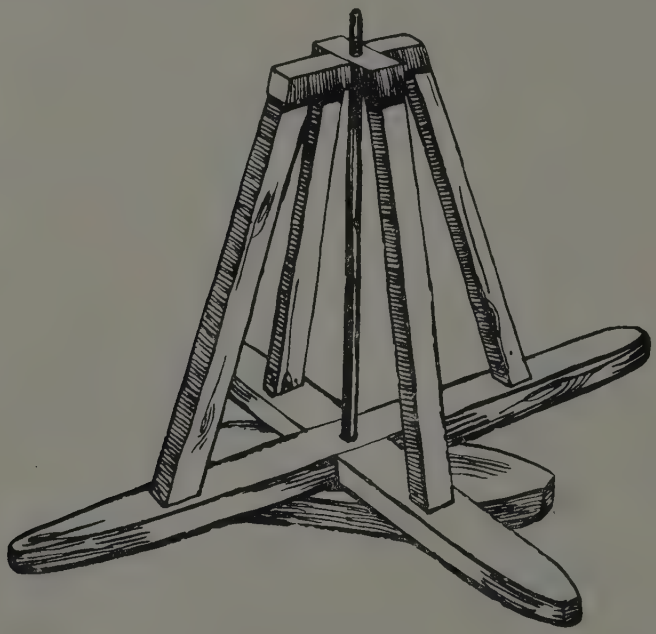


Fig. 5
Unrolling spindle

checked where they cross, and slightly tapered at the ends to lessen the risk of the bottom of the revolving spindle being caught by projections. A hole must be bored in the centre a little larger than the iron bar around which the spindle revolves. The top spindle is made similarly but only 12 in. across. The top and bottom are joined by four pieces of 2 in. by 2 in. by 2 ft. 6 in. long placed in a slanting position. The bar is of 1 in. iron, the lower end sharpened to go one foot into the ground. If there is a tendency for the spindle to pull over it can be steadied by a boy holding the top with a pole through which a $1\frac{1}{4}$ in. hole is bored.

The ordinary coil of fencing wire has an inside diameter of just over 20 in. and the spindle should be made so that the coil just rests on the bottom.

(To be continued)

The Portable Poultry Unit on the Arable Farm

By CHARLES E. CORBETT, *Menengai, Kenya Colony*

The arable farm to-day is a much more highly organized unit than it was ten years ago and the farming system is becoming more diversified. While many enterprises require the outlay of considerable capital from which the return may be somewhat slow, poultry require relatively little capital and the return is not only rapid but high on the money invested.

Apart, however, from their use as a regular source of income the manurial value of the birds' dung for arable land is considerable, provided it is properly conserved and applied. The best means of doing this is by the use of portable units folded regularly over arable land that has been temporarily grassed down for the purpose. This process of "grassing down" is nothing more than natural reversion to the indigenous grass flora, weed growth being controlled by mowing at intervals. In this manner most of the manurial constituents of the dung of the birds (nitrogen, phosphates and potash) reach the soil. The birds also consume harmful insects in considerable numbers and perform mechanical cultivation to the land by scratching and dusting, which aid in the decomposition of dead herbage.

The other advantages of the folding system are numerous. The birds are being moved repeatedly to fresh land containing green grass and insect life. This grass may at certain times of the year be very rich in protein and it frequently contains large amounts of clover, with the result that the feeding costs are lessened. In addition, since the birds are always together in small numbers, each unit comprising only twenty to twenty-five birds, a higher production per bird is secured. Disease is more readily controlled and any bird which is ailing slightly or off colour is readily detected. No cleaning out is required, since all the droppings are left behind on the grass when the unit is moved to a fresh site.

The portable poultry units (diagrams and specifications of which are given in an appendix) were designed by Mr. G. R. Morrison of Rongai, who is the pioneer of the system in this country. Although other types have been constructed by several farmers, the rectangular building of Mr. Morrison's design has proved ideal. Triangular units have not proved satisfactory, as they appear too restricted.

Hitherto the system has been confined to light breeds, in particular the White Leghorn, since heavy breeds fatten excessively under the somewhat restricted conditions and their production is low. Experiments are now being begun with a Rhode Island-Leghorn cross, the object being to improve the stamina and at the same time to maintain a high level of egg production.

Twenty-five birds are kept in each unit, which consists of a house and run made in one piece, the birds being confined in the completely vermin proof house at night. Since the run is completely wired in, there can be no risk of damage by hawks during the day. A non-detachable food box on each side of the unit provides weatherproof accommodation for shell or grit on one side and mash on the other. An old one-gallon oil drum cut in half and wired to the side under the roof of the house provides a suitable container for fresh cool drinking water. The roof of the house is of corrugated iron and although it might be considered excessively hot by day, it is completely weatherproof; and if the end of the run

is covered over with grass or maize trash this will provide the necessary shade for the birds by day. A much used perch is provided by the cross piece in front of the house which also serves to keep the door shut at night. The laying box is at the end of the house, easily accessible from the rear door, by which the slatted floor is removed. These nests consist of a single box with wire netting bottom, which may be sloped backwards in order that the eggs may roll away from the birds and thus escape being eaten by them, as there is usually an odd bird which has this undesirable habit. A door on top of the run enables one to obtain access into either part of it to handle birds or collect eggs laid away from the nests.

Units of the type described above have been given extensive trials on three or four farms in the Rongai district with uniformly satisfactory results. On Vron Farm, Menengai, they have been used for a period of over a year, so that the figures for a full year's production under the system are available. The soil on the farm is light and free draining, consisting largely of loose volcanic ash which responds readily to organic manuring. The units on this farm were made originally by the European manager, but subsequently all have been constructed by an African artisan working under his instructions and a total of some fourteen units are now in use. In addition, the petroltin feeding troughs have been constructed by this artisan.

All these units are now in production, with the exception of one which is being used as a breeding pen and on which the birds are given free range. It is considered desirable that when an enterprise of this nature is started, production should be increased gradually in order to obtain experience and to test the farm for freedom from disease of an epidemic nature. The disease most likely to occur is Kikuyu fowl disease and it is recommended that units should be kept as far as possible from all native hens and all the birds vaccinated at the necessary interval of six months.

Feeding

The feeding that has been adopted is that recommended by the Njoro Station of the Agricultural Department, who advised certain modifications necessitated by the system itself and by the soil and climatic conditions at Menengai. Only good sound grain has been used, although it has been possible to utilize at the same time certain produce which was not readily saleable. Since skim milk has not been available on the farm, animal protein presented a difficulty in view of the scarcity of meat and bone meal. The necessity for the inclusion of this form of protein was soon discovered, since vegetable nutrients (pea meal, etc.) in the absence of skim milk, failed to maintain egg production at its highest level. The problem has, however, now been completely solved by the use of biltong, which is made from old thin working oxen, which would otherwise be unsaleable or which can be purchased very cheaply from neighbouring farmers.

A mineral supplement is included in the mash (containing salt, lime and iron oxide) and oyster shell and grit are always before the birds. Both mash and corn are fed at the rate of $1\frac{1}{2}$ ounces per bird per day.

Daily Routine

Two natives can supervise easily the existing number of units and could probably do a total of twenty without difficulty. Early in the morning each unit is moved to fresh ground, for which a gang of six boys is required. This is

usually done by arranging for a gang of boys on their way to work to assist in the work so that it can be done very rapidly. The slatted floors are then removed from the houses and cleaned, being then left outside all day in the sun to dry and sterilize. Fresh grass is put into the nest boxes, since some of it will have become soiled overnight. Half the corn ration is then fed, water and grit are replenished and any eggs which have been laid during the night are collected. At nine o'clock a feed of kale is given in the form of leaves and stalk chopped longitudinally so as to expose the marrow, and any casualties which may have occurred are brought back to the homestead for treatment. The most common of these is a prolapse of the uterus, due to the somewhat forcing conditions of feeding and housing practised in this system. This complaint can, however, be readily cured by a native. The prolapse is replaced every hour if necessary and the invalid fed on soft food only.

At midday the whole mash ration (1½ ounces per bird) is fed, this being mixed with water to the consistency of a very stiff paste which crumbles readily. Water tins are also refilled if necessary and eggs collected.

At four o'clock the remaining half of the corn ration is fed, eggs are again collected and the slatted floors replaced in the houses, so that only a final visit is necessary at dusk to shut up the houses so as to make them vermin proof.

Although the labour entailed in the above operations may not seem great, yet there is a considerable amount of other incidental work, in particular the grading and washing of the eggs if necessary, packing them ready for delivery and mixing mash and corn rations.

Production Figures

A unit of the type described above was displayed at a recent Agricultural Show in Nairobi by the Department of Agriculture and figures were appended which showed the egg production over a period of one year. Considerable interest was aroused and many farmers were anxious to obtain plans of the unit. These figures are quoted below and represent average number of eggs per bird per month:—

Month	Average per bird per month
1936—April	11·36
May	17·88
June	21·51
July	21·32
August	16·56
September	18·25
October	13·32
November	15·43
December	14·93
1937—January	13·72
February	14·03
March	15·23
April	15·42

The extremely low production in April 1936, was due to the fact that a mash excessively rich in protein had inadvertently been fed previously, and the sudden change in its composition caused this temporary fall off in production. The result of the excessive protein feeding was the appearance of a large number of prolapses and a considerable mortality amongst the birds. The low production in January 1937 coincided with the height of the dry season. Production was raised by 150 per cent when kale was fed regularly, so that there is evidently no need for this fall off in yield during the dry season if an adequate supply of kale is always available. The average egg production for the thirteen months period described above is 16.23 per bird per month, which is probably double the average figure for European egg production in the Colony.

Costs

Since there is a considerable amount of discussion at the present time as to whether poultry are profitable in view of the high prices of feeding stuffs, some estimate of total costs of production is desirable.

Based on prices prevailing for feeding stuffs at the present time (*see* Appendix II) and assuming that the majority have to be purchased, which is not necessarily so on a mixed farm, total costs of production are estimated at 60 cents per dozen eggs. This figure includes feed, labour, European supervision, depreciation on birds and equipment, but not interest on capital.

If for every 100 eggs graded, 60 are specials, i.e. 2 oz. or over, 35 standards, i.e. 1¾-2 oz., and 5 pullets' or cooking (cracked) eggs, on to-day's prices and an average monthly production of 16.23 eggs per bird the total annual income per bird is Sh. 14. At the rate of 60 cents per dozen cited previously the total cost of producing these eggs is Sh. 9/73, which leaves a net profit of Sh. 4/27 per bird per annum or approximately £5 per unit of twenty-five birds. When it is considered that these figures are based on exceptionally high feeding costs and a price for eggs that has not risen in sympathy, the results must be considered highly satisfactory. Furthermore, the figures take no account of the value of the birds as a means of providing manure for the arable land, which, as has been indicated above, is probably appreciable.

Conclusion

The financial success of the portable poultry unit is considered to be definitely established, and it is a system that can be recommended with confidence for the mixed farm. The only drawbacks are its somewhat forcing nature and the fact that it is confined to birds of a light breed, whose stamina is frequently not very good. It is to be hoped that the Rhode Island-Leghorn crossbreds possessing a considerably greater stamina than the purebreds will respond equally well to the system.

APPENDIX I

Portable Poultry Unit

20′ by 5′ 6″ by 3″

(*G. R. Morrison*)

(1) *Materials Required* :

4 pieces 20′ x 3″ x 1″ 1st Class Podo, *cut to length.*

100 feet 3″ x 1″ 2nd Class Podo.
350 feet 2″ x 1″ 2nd Class Podo.
200 feet 4″ x ½″ 2nd Class Cedar.

Above are in running feet, and allow for wastage.

36 bolts 2½″ x ¼″ hex.
12 bolts 3½″ x ¼″ hex.
1½″ and 2″ nails, and 2″ and ½″ screws

1″ mesh wire netting, and a small amount of stout fencing wire, for the front of the feeding boxes.

Miscellaneous requirements include :— Two petrol tins for feeding troughs, old inner tubes for making boxes watertight, ten 4″ "T" hinges, two hasps and staples, three pieces of 6′ corrugated iron, and "Olivum" for painting all woodwork.

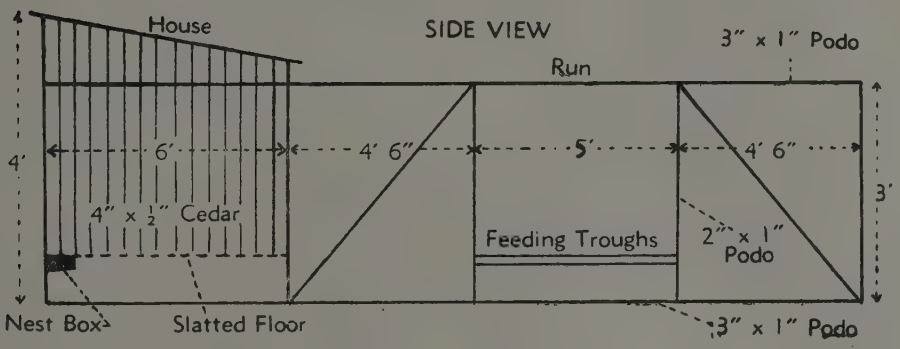
(2) *Diagram of unit, with measurements (not to scale)* (*See facing page*)

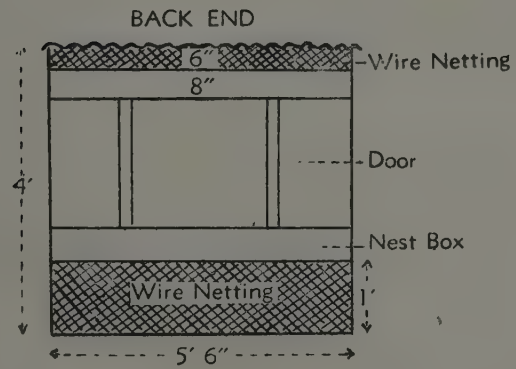
APPENDIX II

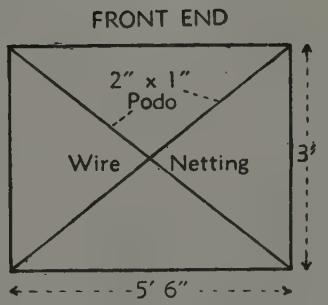
Prices for feeding stuffs on which the figures quoted were based, are as follows :—

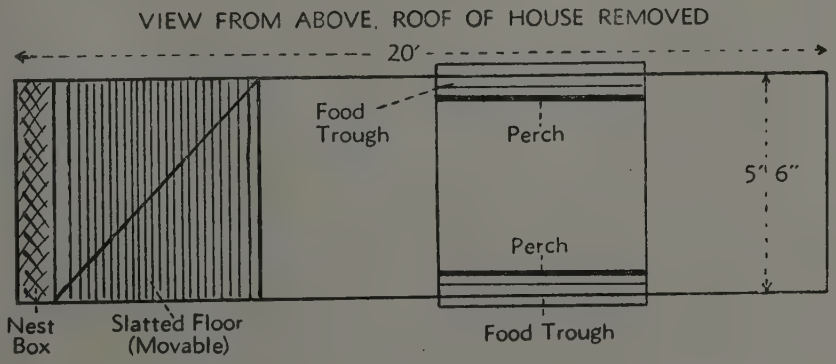
Maize	..	Sh. 7/25 per bag.
Wheat	..	Sh. 15 per bag.
Barley	..	Sh. 11 per bag.
Buckwheat	..	Sh. 6/25 per bag.
Sunflower	..	Sh. 6 per bag.

(N.B.—These diagrams are not to scale.)









Experimental Breeding of Fibre Agaves in East Africa

Part I—The Materials and the Methods of the Breeder

By L. R. DOUGHTY, *B.Sc., N.D.A., Geneticist, East African Agricultural Research Station, Amani, Tanganyika Territory*

INTRODUCTION

The genus *Agave* is indigenous to Central America, Mexico, and the Southern United States. In this region the fibres of certain species have been put to varied used, dependent on their physical characters, by the natives. With an increasing external demand for fibres some of these species have been brought into cultivation. Edwards [3] recognizes eight forms in cultivation in Yucatan, two of which are identified as *A. sisalana* Perrine (sisal) and *A. fourcroydes* Lem. (Henequen). Tobler [9] also draws attention to the variety of forms in cultivation and growing wild in Mexico, which present a wide field for selection. Perrine, recognizing the commercial value of *A. sisalana*, took it to Florida in 1836 in an attempt to establish a fibre industry. It is from this source that most of the sisal cultivated in other parts of the world is derived.

The three most widely cultivated species are in order of decreasing economic importance, *A. sisalana*, sisal, *A. fourcroydes*, Henequen, and *A. cantala* Roxbg., Cantala or Maguey. The last species is cultivated to a limited extent in Java and the Philippines [2]. Sisal was introduced to East Africa from Florida in 1893. The early history of the industry is described by Hindorf [4]. Very few of the plants originally introduced survived; the survivors were the parents of much, probably most, of the sisal now being grown in these countries.

Although the sisal plant is outstanding in many respects as a fibre producer there is always the possibility that more profitable forms exist or may be obtainable by breeding. Hindorf was one of the earliest writers to draw attention to this possibility. In his book he devotes a chapter to a discussion of the directions in which improvement should be sought and the methods of approach. He advocates intensive selection from among the established plantations in East Africa. But historical and cytological evidence indicates that *A. sisalana* in East Africa, and probably universally, is a clone, i.e. the vegetatively propagated offspring of a single original individual. It is the general experience that selection within a clone does not lead to any great improvement; such variation between individuals as is observed is the result of fortuitous circumstances of environment. Hindorf, realizing that the scope for selection would be greatly extended if sexual propagation could play its part, sought diligently for seeds of this species and is the first to record the production of fruits and seeds on cut poles; his seedlings were lost during the war. Reference to breeding work with *Agave* in other parts of the world, much of which ended prematurely, are given by Hunter and Leake [5] in a review of plant breeding activities with economic crop plants.

Breeding experiments with *Agave* were started at Amani in 1929. The primary object of these experiments is an understanding of the fundamental genetics of the plant, in order that the breeding of improved economic types may proceed on a sound basis. But since no breeding of *Agaves* has previously been undertaken in East Africa, the first step has necessarily been on straightforward plant

breeding lines. Thus in this early phase fundamental and applied research have gone hand in hand. The second part of this paper describes the progress that has been made.

Aims

Among the desirable characters of a fibre *Agave* are:—

(1) High yield.
(2) Good quality fibre.
(3) A hardy and adaptable plant.
(4) A plant easily and cheaply cultivated.

(1) Yield is determined by the number of leaves produced and the amount of fibre in the leaf. The amount of fibre in a sisal leaf increases with increasing size and weight of the leaf and a similar relation between leaf size and weight and fibre content appears to exist in other species of *Agave*. The number of leaves produced during the life of the sisal plant does not appear, from the limited data available, to vary greatly between individuals grown under similar conditions; the number and size of the leaves produced are interdependent and largely influenced by environment [1]. For increased production a more rapid growing form with a higher total production of heavy leaves is indicated.

In naturally occurring species prolific leaf production is usually concomitant with small leaves, but this does not necessarily mean that a combination of the characters for numerous and large leaves is incompatible. The results of experimental work designed to effect this combination will be given later.

(2) The fibres derived from *Agave* species form the conducting and supporting tissue of the leaf. The distribution of the fibres in the leaf tissue does not vary greatly in general plan in any of the species examined. Tobler [9] and Nutman [7] and [8] describe the distribution of the fibres and their structural characters and illustrate the appearance of fibres in the leaf section.

The general standard of quality of common sisal fibre is considered quite satisfactory by the consumer for the purposes to which it is now put. Length, colour and strength are the main points considered in marketing. The Imperial Economic Committee [6] point out that the absorption of supplies of sisal fibre depends largely on finding extended uses for this kind of fibre and Wigglesworth [10] states that the future policy of the sisal grower must be directed towards producing finer fibre. To what extent a finer fibre would fulfil the requirements for fine spinning is conjectural. A good deal of attention has been given to the conversion of sisal fibre into a material suitable for fine spinning, to replace the softer fibres used in commerce. The physical qualities of the fibre are therefore given an important place in the breeding programme. A technique enabling comparisons of the qualities of fineness and strength of the fibre from small samples has been evolved and described by Nutman [7].

Colour of the fibre is connected with clean decortication; the fibre must be freed completely from adherent pulpy matter. The ease with which modern machinery can decorticate the leaf differs in the different species of *Agave*. Leaves containing a very fine fibre seem to be more difficult to decorticate cleanly. Since most of our test decortications of types of leaves containing fine fibre have been carried out on machinery set for sisal leaf, this may be a matter of mechanical adjustment and not a serious difficulty.

(3) The sisal plant is cultivated over a wide range of conditions. It is adaptable

and singularly free from attack by serious pests and disease. Some species of *Agave*, e.g. *A. ingens*, appear to be very susceptible to attack by the sisal weevil. Others, e.g. *A. Lespinassei*, to diseases which are said to be due to soil deficiencies, banding disease, leaf scorch, etc., susceptibilities to be looked for by the plant breeder since they may be a serious drawback in otherwise promising types.

(4) The presence of spines on the leaf margin is a great disadvantage in cultivation; plants with marginal spines take very much longer to cut and are more difficult to cultivate than those without. The production of stable forms with non-spiny leaf margins is of great importance. The absence of marginal spines in *A. sisalana* is not an immutable character; parent plants with non-spiny margins frequently produce bulbil and sucker offspring with spiny leaf margins and *A. amaniensis*, blue sisal, typically a non-spiny form, occasionally produces bulbils and suckers with marginal spines.

Materials and Methods

The introductory remarks have indicated the limitations imposed on selection among the sisal population of East Africa. A thorough exploration of the potentialities of species in the home of the genus is at present impracticable. The interest of botanists and horticulturists in *Agave* had led to the introduction of many species to European gardens, forming a valuable source of material for comparative study and selection. With the assistance of the Royal Botanic Gardens, Kew, the late Sir Cecil Hanbury, M.P., La Mortola, Italy, Col., the Hon. M. T. Boscawen, Mtotohovu, Tanga, and several institutions in the United States, we have now a collection of eighty-eight species and varieties of *Agave* growing at Amani. Most of the fibre-producing species belong to the group Rigidae of *Euagave* and twelve species in this group are represented in the collection.

Seedling progeny of many species show a very wide range of variation of vegetative characters and thus provide ample scope for selection. Species in *Agave* are generally classified according to their vegetative characters and this wide variation amongst seedlings may be one explanation for the very large number of species that have been described—532 species, including synonyms and *nomina nuda* are recorded in the Index Kewensis up to 1930.

Sexual sterility, either partial or complete, is a feature of many species in the Rigidae section (to which most attention has naturally been paid) and is a hindrance to inbreeding and to interspecific hybridization. The method adopted for inbreeding and crossing has been to utilize as female parents species that exhibit some desirable characters and that also set fruit comparatively freely. Pollen is taken from the less freely fruiting parent, since male sterility is not usually so marked as female sterility.

A scaffolding has to be erected round each plant used in the cross (Fig. 1) and the inflorescence protected from visiting insects by enclosure in a mosquito netting cage. Emasculation is a simple procedure as all six anthers are extruded from the apex of the bud a day before they shed their pollen and two to three days before the stigma is receptive. The morphology of the flower is illustrated in Fig. 2. On the left is the closed bud, cut open to show the flexed filaments supporting the anthers, and the short style. In the centre the filaments are fully extended and the anthers ready to shed their pollen at the appropriate time; the style is extending. On the right the style is shown fully extended with the wilted and exhausted anthers hanging over to

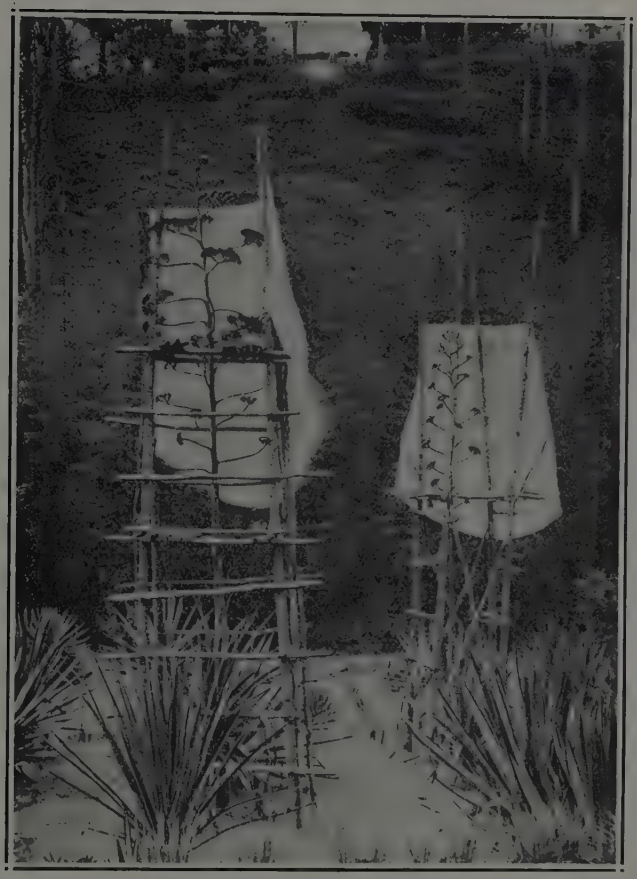


FIG. 1
Scaffolding erected for crossing agaves

FIG 2
Flowers of *Agave sisalana* from a seedling plant. (Natural size)

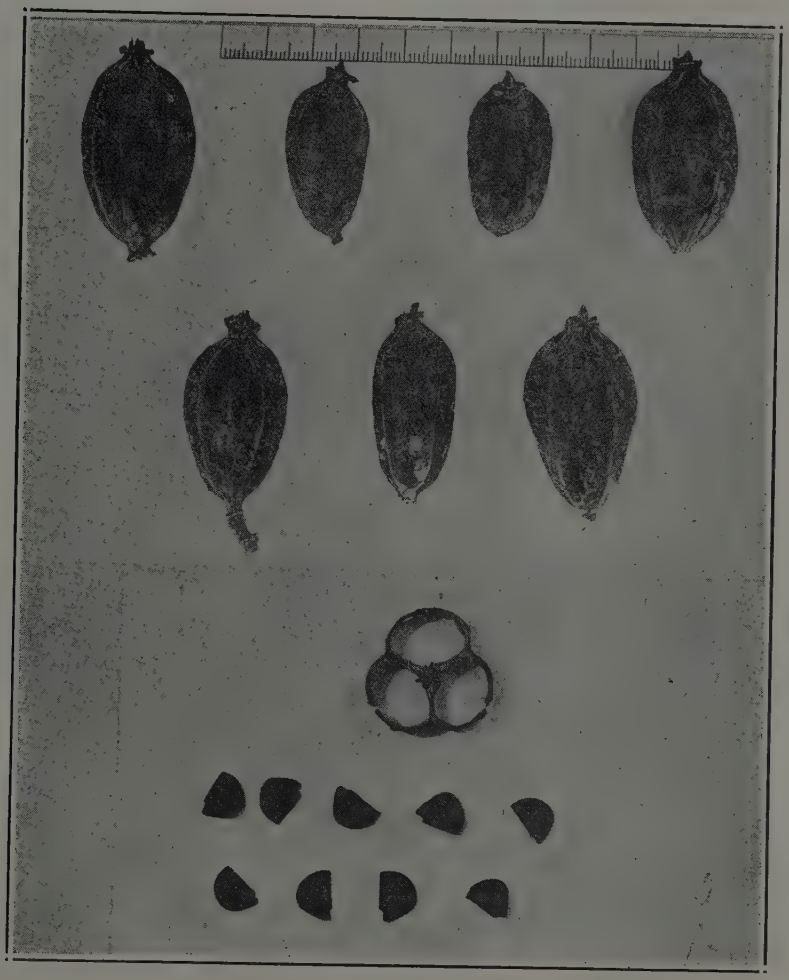


FIG 3
Fruits and seeds of *A. amaniensis* (×·6)

the right. When the stigmatic surface at the top of the style is receptive a sticky fluid is exuded.

The inflorescence of the male parent is not usually protected. Flowering branches are cut off and kept in water in the laboratory, the pollen being collected in a glass vessel and then applied to the receptive stigmas of the female parent with a brush. Pollen remains viable for at least a week. If flowers are left on the parent plant without protection bees very quickly remove all traces of pollen in spite of the late hour in the evening (6.30 p.m. onwards, LST) at which the anthers begin to dehisce. Fruits ripen about six months after the pollination of the flowers. Fertile seeds (Fig. 3) are thin, triangular-rounded, black and papery; unfertilized ovules remain white and papery. The seeds are carried in two rows in each of the three loculi.

Artificial pollination results in a much greater set of fruits than open pollination, but even so the number of seeds obtained is usually only a small proportion of the possible maximum; counts of the number of ovules in a fruit give totals in excess of three hundred and it is very rarely that more than 150 viable seeds are obtained from a fruit.

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The Effect of Growth Substances on the Stimulation of Root Growth in Cuttings of *Coffea arabica*

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FOREWORD

Previous attempts to root cuttings of *Coffea arabica* at the Scott Agricultural Laboratories, although not completely negative, have given a poor percentage of success. The first trial carried out in which cuttings were treated with Hortomone "A" (1 part in 320 parts of water) for a period of eighteen hours prior to planting in the propagator gave results sufficiently conclusive to prove that a definite initiation of root growth had been obtained. These results led to the laying down of an experiment which is described below.

THE EXPERIMENT

Substances used

(*a*) Hortomone "A" is a new product for the stimulation of root growth, which has been prepared and recently placed on the market by Messrs. Imperial Chemical Industries, Ltd.

(*b*) *B* Indolyl Acetic Acid has already been found by workers in other countries to stimulate the activity of the cambium and root growth.

Objects

The object of the experiment was two-fold:—

(*a*) Firstly, to determine whether Hortomone "A" and *B* Indolyl Acetic Acid had any effect on the initiation of root growth of cuttings of *C. arabica.*

(*b*) Secondly, to determine at what strength these substances should be used to obtain the optimum results.

Treatments

The cuttings were treated with the following strengths of Hortomone "A" and *B* Indolyl Acetic Acid prior to planting in the propagator:—

A—Hortomone "A"—1 part in 1,200 parts of water.

B—Hortomone "A"—1 part in 600 parts of water.

C—Hortomone "A"—1 part in 300 parts of water.

D—Hortomone "A"—1 part in 150 parts of water.

E—*B* Indolyl Acetic acid—1 part in 10,000 parts of water.

F—*B* Indolyl Acetic acid—4 parts in 10,000 parts of water.

G—Control—tap water.

The cuttings, having been treated for eighteen hours in the above solutions, were rinsed in tap water and planted in the propagator.

Description of method and lay-out employed

The propagator (Fig. I) used is a new and improved type recently constructed. It is sunk below ground level to ensure satisfactory insulation and a roof, thatched with grass, is placed over the frame each evening in order to prevent appreciable changes of temperature occurring. Bottom heat is supplied to the rooting medium by two small hurricane lamps placed in a chamber underneath. The rooting medium, which was kept at a fairly constant temperature of 24° C.,

FIG. I
The propagator

consisted of a mixture of equal parts of peat moss and sand.

The cuttings were taken from two parent trees that had previously been bent over to encourage sucker growth. Each cutting was selected for evenness of size, type, etc. The cuttings, averaging 10 cms. in length, were of unripened and current season's terminal growth with two leaves; the basal cut being made immediately below a node and at right angles to the axis of the cutting. After removal from the parent trees they were trimmed and placed in beakers in which the different strengths of Hortomone "A" and *B* Indolyl Acetic acid had been prepared.

A clone of forty-nine cuttings was taken from each parent tree; so that seven cuttings from each clone were subjected to each of the seven treatments. The two clones were planted side by side in the propagator in the form of two seven-sided latin squares. The following was the actual lay-out:—

E	A	D	B	F	C	G
C	B	G	F	A	E	D
G	D	A	C	E	F	B
A	F	B	E	G	D	C
B	C	E	A	D	G	F
F	G	C	D	B	A	E
D	E	F	G	C	B	A

CLONE I

C	F	G	B	A	D	E
B	C	A	G	D	E	F
A	G	B	C	E	F	D
F	A	D	E	B	G	C
D	E	F	A	G	C	B
E	B	C	D	F	A	G
G	D	E	F	C	B	A

CLONE II

The object of randomizing the cuttings in this manner was to minimize the influence of slight uneven heating of the rooting medium, a difficulty experienced in the past with the type of heating used in this propagator; and also to overcome a possible positional factor of any set of cuttings in the propagator (e.g. it has been found that cuttings planted near the walls of the propagator tend to root quicker than those in the centre).

In order to prevent the solutions absorbed by the cuttings during treatment escaping from one cutting to another in the propagator, each cutting was inserted in a waxed paper container, seven inches long and three inches in diameter. The cuttings were submerged for two-thirds to three-quarters of their length in the rooting medium.

Treatment of cuttings whilst in the propagator consisted of a fine spraying of the leaves twice daily with rain-water to maintain high humidity and water at about 24° C., containing Cheshunt compound, was given to the rooting medium when necessary.

Results

After remaining in the propagator for a period of sixty-four days, the cuttings were examined.

The following tables give the results obtained:—

Treatment	Clone I			Clone II			Total of Two Clones		
	No. rooted	No. un-rooted	No. dead	No. rooted	No. un-rooted	No. dead	No. rooted	No. un-rooted	No. dead
A ..	1	6	0	1	5	1	2	11	1
B ..	3	2	2	2	4	1	5	6	3
C ..	3	2	2	6	0	1	9	2	3
D ..	7	0	0	6	1	0	13	1	0
E ..	7	0	0	4	2	1	11	2	1
F ..	0	4	3	2	3	2	2	7	5
G ..	0	6	1	1	5	1	1	11	2

Treatment	Rooted
	%
A — Hortomone "A": 1 part in 1,200 parts of water	14·3
B — Hortomone "A": 1 part in 600 parts of water	35·7
C — Hortomone "A": 1 part in 300 parts of water	64·3
D — Hortomone "A": 1 part in 150 parts of water	92·9
E — B Indolyl Acetic Acid: 1 part in 10,000 parts of water	78·6
F — B Indolyl Acetic Acid: 4 parts in 10,000 parts of water	14·3
G — Control: Tap water	7·1

Fig. II
Clone I—Cuttings after removal from propagator

FIG. IIA
Clone II—Cuttings after removal from propagator

These results show (*a*) that the increase in the number of cuttings rooted is correlated to the increasing strength of Hortomone "A" used and that a strength of 1 part Hortomone "A" to 150 parts of water will produce a high percentage of success;

(*b*) that a definite stimulation of root growth has taken place when the cuttings were treated with 1 part of *B* Indolyl Acetic acid to 10,000 parts of water; but that a marked decrease in the incidence of rooting is noticeable when the strength of this substance is increased to 4 parts in 10,000 parts of water. From the tables given above it will be observed that in the case of this stronger solution of *B* Indolyl Acetic acid the number of "dead" cuttings is appreciably higher; observations made during the course of the experiment have also shown that leaf fall is more severe with this treatment. It would thus appear that at this strength *B* Indolyl Acetic acid becomes semi-lethal.

Conclusions

The following conclusions can be drawn from the experiment: —

(*a*) That both substances used—Hortomone "A" and *B* Indolyl Acetic acid—assist in stimulating root growth.

(*b*) That the optimum strength to use Hortomone "A" has not been definitely ascertained but a strength of 1 part in 150 parts of water can be safely used and a high percentage of rooting can be expected.

(*c*) That a good percentage of rooting can be expected by treating cuttings in 1 part *B* Indolyl Acetic acid to 10,000 parts of water.

(*d*) That a strength of 4 parts of *B* Indolyl Acetic acid to 10,000 parts of water is semi-lethal and for this reason root growth is inhibited.

(*e*) That further trials are necessary using stronger solutions of Hortomone "A" and weaker solutions of *B* Indolyl Acetic acid.

(*f*) That the appearance of the aerial growth of the cuttings gives no indication of the incidence of rooting.

(*g*) That the method employed of randomizing the cuttings and isolating each in a waxed paper pot has given very satisfactory experimental results.

General

Further work is necessary before the best results with these substances can be obtained. Whilst a range of different strengths of Hortomone "A" has been satisfactorily tested out, the possible influence of time at which the cuttings should be allowed to remain in the solutions has not been ascertained. This and other important factors call for more experimentation, but it is felt that the results to date have been so outstanding that they should be brought to the immediate notice of other workers engaged on the propagation of *C. arabica,* or other tropical crops, in the hope that they will prove of interest and assistance to them.

Acknowledgments

The writers' thanks are due to Capt. B. Allen, the East African representative of Messrs. Imperial Chemical Industries, Ltd., for supplying the Hortomone "A" and to the Senior Agricultural Chemist (Mr. V. A. Beckley) for much assistance and helpful suggestions throughout.

Annotated Host List of Uganda Parasitic Fungi and Plant Diseases—Part IV

By C. G. HANSFORD, *M.A., F.L.S., Mycologist, Department of Agriculture, Uganda Protectorate.*

ASCLEPIADACEAE.

ASCLEPIAS sp. (Indigenous).

Rhizopus stolonifer (Ehrenb.) Lind., rot of fruit.

SECAMONE sp. (Indigenous).

Hemileia secamones Hansford, rust.

Uromyces secamones Wakef., rust.

TYLOPHORA sp. (Indigenous).

Helminthosporium tylophorae Hansford.

RUBIACEAE.

CANTHIUM sp. (Indigenous).

Saccardinula canthii Hansford.

Micropeltella ugandae Hansford.

CINCHONA sp. (Quinine).

Cercospora cinchonae E. & Ev.

Rhizoctonia lamellifera Small, root disease.

COFFEA ARABICA (Coffee).

Nematospora coryli Pegl., inside seeds, after attack by *Antestia* coffee bug.

Capnodium brasiliense Putt., sooty mould on leaves.

Glomerella sp., with *Colletotrichum* conidial stage (possibly identical with *G. coffeicola* Averna-Sacca, which has conidial stages *Colletotrichum incarnatum* Zimm., *Diplodia coffeicola* Zimm., and *Cytosporina coffeicola* Av.-Sacca), causes blotches on leaves and young parts of the stem; as a rule the damage is unimportant in Uganda.

Hemileia vastatrix B. & Br., rust, "leaf disease". Recent opinion in Uganda is that severe damage from this disease indicates that the host is suffering from adverse conditions of climate, cultivation or soil, or often from the strain on its resources in carrying and ripening a heavy crop. The result of this attitude is that no measures are now taken here directly aimed at control of *Hemileia,* but attention is devoted to improvement of the general health of the coffee to enable it to withstand attack.

Polyporus coffeae Wakef. This fungus is associated with the mealy bug, *Pseudococcus citri,* to cause a root disease of coffee. Affected trees show a rubbery coating of fungus mycelium, up to ½ inch thick, over the larger roots and base of the tree; under this layer are numerous mealy bugs. The trees gradually die off, and the fungus fruits at the base of old dead trees. The disease is uncommon, and usually limited to odd trees on an estate. It has not been reproduced by inoculation.

Armillaria mellea (Vahl.) Fr., root rot, not common on *arabica* coffee.

Cercospora coffeicola B. & C., leaf spot and berry blotch; of little importance in Uganda, except on seedlings in the nursery; on the recently introduced Harar variety this disease has proved more serious and causes severe defoliation.

Rhizoctonia solani Kuhn, and *R. bataticola* (Taub.) Butl., attack seedlings in the nursery, causing a "damping off" disease, which is liable to spread rapidly through affected beds. The disease is associated with damp conditions and with overcrowding of the seedlings, and where these predisposing causes are controlled the disease is not serious and may be avoided altogether.

Rhizoctonia lamellifera Small is common on dead and dying coffee roots, especially on the fine branches. There is some doubt as to its status on these fine rrots, whether parasitic or saprophytic; it is known, however, that under favourable circumstances it is able to travel back in the tissues into the main roots and base of the tree, and death follows.

A number of other fungi have been recorded in Uganda on *arabica* coffee, but most are saprophytic on dead or dying tissues: *Phoma* sp., *Phomopsis* sp., *Gnomonia* sp., *Coniothyrium* sp., *Hendersonia (coffeae* Del.?), *Septoria coffeae* Wakef., *Fusarium* sp., *Stilbella* sp.

Fusarium sporotrichioides Sherb. has been isolated on several occasions from the stamens of flowers which refuse to open in a normal manner, and prove sterile; inoculation experiments failed to reproduce the disease.

COFFEA EUGENOIDES (Indigenous).
Hemileia vastatrix B. & Br., rust.

COFFEA EXCELSA.
Hemileia vastatrix B. & Br., rust.
An unidentified fungus forms black patches on the surface of the leaves, and has not been encountered on any other host.

COFFEA LIBERICA.
Hemileia vastatrix B. & Br., rust.

COFFEA ROBUSTA.
Nematospora coryli Pegl., inside seeds attacked by *Antestia*.
Irenina glabra (B. & C.) Stev., forms small black patches on leaves, stems and berries; though parasitic on the epidermis no appreciable harm results; though common on this host it has not been recorded from *C. arabica* in Uganda.
Meliola coffeae Hansford, rare, on leaves.
Capnodium brasiliense Putt., sooty mould on leaves.
Glomerella coffeicola Av.-Sacca.
Hemileia vastatrix B. & Br., rust, of little importance on this host; when parasitized by *Cephalosporium* sp. the latter often penetrates the tissue of the leaf, and dark brown leaf spots develop around the site of the original rust infection.
Polysporus coffeae Wakef., "mealy-bug root disease," rather more common than on *C. arabica*.
Armillaria mellea (Vahl.) Fr., root rot.
Pestalozzia sp., on leaves.
Cercospora coffeicola B. & C., leaf spot.
Rhizoctonia solani Kuhn., and *R. bataticola* (Taub.) Butl., seedling diseases.
Rhizoctonia lamellifera Small, root disease.

CRATERISPERMUM sp. (Indigenous).
Meliola vicina Syd., on leaves.

MITRACARPUM sp. (Indigenous).
Wageria sp., on leaves.
Aecidium mitracarpi Syd., rust.

MOTANDRA sp. (Indigenous).
Asterina sp., on leaves.

MUSSAENDA sp. (Indigenous).
Wageria sp., on leaves.

OLDENLANDIA sp. (Indigenous).
Meliola oldenlandiae Hansford & Stevens.
Puccinia oldenlandiae P. Henn., rust.
Cercospora oldenlandiae Hansford, leaf spot.

OXYANTHUS sp. (Indigenous).
Micropeltella ugandae Hansford, on leaves.

PAVETTA sp. (Indigenous).
Balladynopsis ugandensis Hansford.
Micropeltella sp.
Aecidium flavidum B. & Br., rust.
Meliola mitchellae Cooke:
All these on leaves.

PENTAS sp. (Indigenous).
Meliola psychotriae Earle.
Puccinia pentadicola Grove, rust.
Puccinia pentadis-carneae Wakef., rust.

PSYCHOTRIA sp. (Indigenous).
Hemileia holstii Syd., rust.
Meliola longiseta v. Hohnel.
Meliola mitchellae var. *longiseta* Hansford.

RUBIA sp. (Indigenous).
Puccinia dimorpha Syd., rust.
Puccinia rubiicola Syd., rust.

SPERMACOCE sp. (Indigenous).
Puccinia lateritia B. & Curt., rust.

VANGUERIA sp. (Indigenous).
Aecidium vangueriae Cooke, rust.

HOSTS indet. (Indigenous).
Amazonia asterinoides (Wint.) Theiss.
Meliola kibirae Hansford & Stevens.
Meliola Smallii Hansford & Stevens.
Balladynopsis ugandensis Hansford.
Scoleçopeltis sp.
Micropeltis sp.
Englerulaster sp.
Meliola woodiana Sacc.
M. woodiana var. *aristata* Hansford.
Dichaetis sp.
Wageria sp.
Asterina sp.

COMPOSITAE.

AGERATUM CONYZOIDES (Indigenous).
Heptameria obesa (Dur. & Mont.) Sacc., on dead stems.
Aecidium agerati P. Henn., rust.
Cladosporium herbarum Lk., f., forms mouldy patches on the lower surface of the leaf; parasitic.

ASPILLA sp. (Indigenous).
Uromyces aspiliae Wakef. & Hansf.; on other collections *Uredo* sp. and *Aecidium* sp. have been found, and may be connected with this.

BERKHEYA SPEKEANA (Indigenous).
Puccinia berkheyae Wakef., rust.

BIDENS PILOSA (Indigenous).
Uromyces bidentis Lagerh., rust.
Cercospora megalopotamica Speg., leaf spot.
? *Entyloma* sp., leaf spot.

BLUMEA sp. (Indigenous).
Aecidium blumeae P. Henn., rust.

CARDUUS sp. (Indigenous).
Puccinia cnici-oleracei Pers., rust.
Puccinia sp.

CONYZA sp. (Indigenous).
Aecidium macowanianum Thum., rust.

COREOPSIS sp. (Indigenous).
Puccinia coreopsidis Wakef., rust.
Uredo sp. on *C. Grantii*, rust.
Irenina cyclopoda (Stev.) Stev., on leaves.
Irenina glabra (B. & C.) Stev., on leaves.

COSMOS BIPINNATUS (Cultivated).
Oidium sp. (? *Erysiphe cichoracearum* DC.), mildew.

DAHLIA sp. (Cultivated).
Entyloma dahliae Syd., leaf spot.
Rhizoctonia bataticola (Taub.) Butl., root disease.

DICHROCEPHALA sp. (Indigenous).
Aecidium dichrocephalae P. Henn., rust.

ECHINOPS sp. (Indigenous).
Puccinia pulvinata Rabh., rust.

EMILIA SCORDIFOLIA (Indigenous).
Plasmopara halstedii (Farl.) Berl. & De Toni, downy mildew.

ERLANGEA TOMENTOSA (Indigenous).
Dimeriella claviseta Doidge, on leaves.
Puccinia erlangeae Grove, rust.

GAZANIA sp. (Cultivated).
Sclerotium rolfsii Sass., root disease.

GUIZOTIA ABYSSINICA.
Rhizoctonia bataticola (Taub.) Butl., root disease.

GYNURA sp. (Indigenous).
Aecidium gynurae Wakef. & Hansford, rust.

HELIANTHUS ANNUUS (Sunflower).
Helminthosporium helianthi Hansford, leaf spot.
Cercospora pachypus Ell. & Kell., leaf spot.
Alternaria tenuis Bolle, f., leaf spot.
Sclerotium rolfsii Sacc., root disease.
Rhizoctonia bataticola (Taub.) Butl., root disease.

HELICHRYSUM sp. (Indigenous).
Puccinia kalchbrenneri De Toni, rust.
Isariopsis helchrysi Hansford, leaf spot.

INULA sp. (Indigenous).
Uredo sp., indet., rust.

LACTUCA CAPENSIS (Indigenous).
Puccinia lactucae-capensi Wakef. and Hansf., rust.
Aecidium sp., rust.
Septoria lactucae Pass., leaf spot.
Cercospora longissima (Cug.) Sacc., leaf spot.

LAGGERA ALATA (Indigenous).
Nectria sp., on dead stems.

MELANTHERA sp. (Indigenous).
Uromyces melantherae Cooke, rust.

MICROGLOSSIA sp. (Indigenous).
Puccinia aurata Syd., rust.
Aecidium microglossae Petch.

SENECIO sp. (Indigenous).
Aecidium senecionis-bipleuroidis Syd., rust.

SONCHUS sp. (Indigenous).
Puccinia sonchi Rob., rust.
Rhinotrichum sonchi Hansford, leaf spot.
Alternaria sonchi Davis, *apud* Elliott, leaf spot.

SPILANTHES ACMELLA (Indigenous).
Puccinia africana Cooke, rust.

VERNONIA sp. (Indigenous).
Dimeriella claviseta Doidge, on leaves.
Irenina glabra (B. & C.) Stev., on leaves.
Mycosphaerella dummeri Hansford, leaf spot.
Ophiobolus butleri Syd., prox., on dead stems.
Tryblidiella rufula (Spreng.) Sacc., on dead stems.
Puccinia hansfordii Wakef., rust.
Puccinia le-testui Maubl., rust.
Puccinia vernoniicola P. Henn., rust.
Aecidium vanderystianum P. Henn., rust.
Uredo vernoniae P. Henn., rust.
Cladosporium herbarum Lk., var., causes mouldy patches on leaves; parasitic.
Cercospora sp., leaf spots.

WEDELIA sp. (Indigenous).
Irenina glabra (B. & C.) Stev., on leaves.
Puccinia melampodii Diet. & Holw., rust.

ZINNIA ELEGANS (Cultivated).
Oidium sp. (? of *Erysiphe cichoracearum* DC.), mildew on flowers and branches, not recorded from leaves; the flowers shivel instead of opening.
Cercospora (*zinniae* Ell. & Mart. ?), leaf spot.

PLUMBAGINACEAE.

PLUMBAGO sp. (Indigenous).
Meliola plumbaginis Hansford, on leaves and stems, strongly parasitic.

PLANTAGINACEAE.

PLANTAGO sp. (Indigenous).

Meliola plantaginis Hansford, on leaves.

SOLANACEAE.

CAPSICUM ANUUM (Chillies).

Colletotrichum nigrum E. & H.

Vermicularia capsici Syd.

Gloeosporium piperatum E. & Ev.

These three fungi all attack the fruit of this host in Uganda, and tend to invade the stems through the dying tissues of the infected fruit; in severe cases considerable dieback of the plants may follow, but such cases are comparatively rare here. The crop is of little importance in Uganda.

Rhizoctonia bataticola (Taub.) Butl., attacks the roots, especially those of weakly plants.

Sclerotium rolfsii Sacc., root disease; rare.

Alternaria tenuis Bolle, f., leaf spot, and fruit rot.

Mosaic Disease. This occurs in Uganda; affected plants show mottled leaves, which are often distorted; the plants are often dwarfed and rather more wranched than is normal; such plants are usually sterile.

DATURA sp. (Indigenous).

Alternaria crassa (Sacc.) Rands, leaf spot.

NICOTIANA TABACUM (Tobacco).

Pythium sp., "black shank". The fungus enters the roots from the soil, and causes collapse and browning of roots and base of the stem; the pith of the stem is contracted into thin diaphragms across the hollow woody cylinder; affected plants rapidly wither and die; hitherto recorded only from Kampala and Serere Plantations.

Erysiphe cichoracearum DC., mildew; uncommon.

Cercospora nicotianae E. & Ev., "frog eye spot," common in Uganda, especially on ripening leaves.

Alternaria longipes (E. & Ev.) Mason, leaf spot.

Alternaria tenuis Bolle, f., leaf spot, probably secondary after *Cercospora.*

Rhizoctonia bataticola (Taub.) Butl., root disease, uncommon.

Bacillus aroideae Towns., "hollow stalk"; a rot of the stem occurs from the top, after topping has been carried out; rare in Uganda.

Bacterium angulatum Fromme & Murray, "angular leaf spot," on occasional plants all over Uganda; not a serious disease here as yet.

Mosaic Disease, common all over Uganda, spread chifly by contact between plants and by cultivators handling healthy plants after their hands have become contaminated with the virus from diseased plants.

Leaf Curl, common in Bunyoro; an account has recently been published by Storey (*E. Afr. Agric. Journ.,* I, 148, 1935).

Heterodera radicicola, eel-worm, causes the "root knot" disease of this and many other plants in Uganda; affected tobacco plants make very poor growth; the disease shows signs of increasing in incidence on this crop.

PHYSALIS PERUVIANA (Cape Gooseberry).

Entyloma physalidis (Kalch. & Cooke) Wint., leaf spot.

Rhizoctonia bataticola (Taub.) Butl., root disease; uncommon.

SOLANUM LYCOPERSICUM (Tomato).

Septoria lycopersici Speg., leaf spot; the local form of this fungus does not cause the serious disease recorded in the U.S.A.

Cladosporium fulvum Cke., leaf mould; only occurs in quantity at Kampala during cool, wet weather.

Alternaria solani (E. & M.) Jones & Grout, leaf spot.

Cercospora sp., leaf spot.

Verticillium albo-atrum Reinke & Berth., causes wilt when inoculated through the soil; no cases have yet been noticed in native cultivations.

Rhizoctonia solani Kuhn, and *R. bataticola* (Taub.) Butl., have been recorded from roots of seedlings and of mature plants.

SOLANUM MELONGENA (Egg Plant).

Cladosporium fulvum Cke., leaf mould, rare on this host.

Alternaria solani (E. & M.) Jones and Grout, leaf spot.

Cercospora (*melongenae* Welles ?), leaf spot.

Verticillium albo-atrum R. & B., wilt disease.

Fusarium sp., fruit rot.

Heterodera radicicola, eel-worm on roots.

SOLANUM TUBEROSUM (Potato).
Actinomyces scabies (Thaxt.) Gussow, scab, not common.
Colletotrichum tabificum Pethybr.
Verticillium albo-atrum R. & B., wilt disease; produced by inoculation; not yet found in field.
Alternaria solani (E. & M.) Jones and Grout, leaf spot, "early blight"; causes serious defoliation on occasion in Uganda, and crop is reduced in these cases.
Cercospora concors (Casp.) Sacc., leaf spot; this with *Alternaria* causes the most serious disease of potatoes in Uganda; in most cases of severe attack both fungi are present.
Rhizoctonia solani Kuhn, root and tuber disease, uncommon.
Rhizoctonia bataticola (Taub.) Butl., root and tuber disease; rare on tubers.
Bacillus (*phytophthorus* Appel. ?), a bacterial disease of potato is known to occur in some areas in Uganda, but definite identification has not yet been made.

SOLANUM sp. (Indigenous).
Oidium sp., mildew.
Asterina solani-torvi Hansford, on leaves.
Aecidium sp., near *habungense* P. Henn., rust.
Aecidium sp., near *solani-unguiculati* P. Henn., rust.
Colletotrichum lycopersici Chester, on fruit.
Cercospora solani Thum., leaf spot.

CONVOLVULACEAE.

ASTROCHLAENA sp. (Indigenous).
Aecidium astrochlaenae Wakef. & Hansf., rust.

IPOMOEA BATATAS (Sweet Potato).
Pythium sp., rot of surface layers of tubers; rare.
Rhizoctonia bataticola (Taub.) Butl., sterile stage of *Macrophomina phaseoli* (Maubl.) Ashby, common rot of tubers.
Fusarium sp., tuber rots; not as common as *Rhizoctonia*.

IPOMOEA sp. (Wild, Indigenous).
Cystopus ipomoeae-pes-caprae Cif., white pustules on leaves.
Meliola clavulata Wint., on leaves.
Meliola malacotricha Speg., on leaves.
Asterina sp., on leaves.
Coleosporium ipomoeae (Schw.) Burr., rust.
Uromyces ipomoeae Berk., rust.
Puccinia holosericea Cooke, rust.
Ascochyta sp., leaf spot.
Alternaria sp. (of *A. solani* group), leaf spot.
Cercospora (*ipomoeae* Wint. ?), leaf spot.

LEPISTEMON sp. (Indigenous).
Meliola lepistemi Hansford, on leaves. leaves.

STICTOCARDIA BERAVIENSIS (Indigenous).
Meliola malacotricha Speg.

HOST indet. (Indigenous).
Meliola clavulata Wint.
Puccinia holosericea Cooke.

SCROPHULARIACEAE.

ALECTRA sp. (Indigenous).
Cercospora sp., leaf spot.

SCOPARIA sp. (Indigenous).
Aecidium scopariae Wakef. & Hansf.

BIGNONIACEAE.

KIGELIA sp. (Indigenous).
Meliola bidentata Cooke, on leaves.

MARKHAMIA PLATYCALYX (Indigenous).
Meliola markhamiae Hansford & Stevens.
Meliola kampalense Hansford & Stevens.
Meliola lanceolata-setosa Syd.
? *Uredopeltis congensis* P. Henn., rust.
Uredo sp., rust.
Cercospora leprosa Syd., leaf spot.
Cercospora dolichandrones Hansford, leaf spot.
All the above fungi occur on leaves.

SPATHODEA sp.
Armillaria mellea (Vahl.) Fr., root rot; rare.

PEDALINEAE.

SESAMUM sp. (*S. indicum*, Simsim, cultivated, and *S.* sp., wild).
Gloeosporium macrophomoides Sacc.
Alternaria macrospora Zimm., leaf spot, also on stems.
Cercospora sesami Zimm., leaf spot.
Helminthosporium sesameum Sacc., leaf spot.
Cylindrosporium sesami Hansford, leaf spot.
Fusarium oxysporum Schlecht., f., wilt disease.
Rhizoctonia bataticola (Taub.) Butl., root disease; the sporing stage *Macrophomina phaseoli* (Maubl.) Ashby, is common on this host in Uganda; the disease is serious on occasion, but is often associated with unsuitable soil. this crop being very sensitive to soil and climatic conditions.

Verticillium albo-atrum R. & B., wilt disease.
Bacterial Stem Disease, at present unidentified.

ACANTHACEAE.

ACANTHUS sp. (Indigenous).
Aecidium acanthi ALS., rust.
Brachysporium acanthi Hansford, leaf spot.

DYSCHORISTE sp. (Indigenous).
Oidium sp., mildew, common.

HYPOESTES sp. (Indigenous).
Uredo hypoestes (Cke) De Toni, rust.

JUSTICIA sp. (Indigenous).
Plasmopara willdemanniana P. Henn., downy mildew.
Irenina irregularis Stev., on leaves.
Meliola psychotriae Earle, on leaves.
Aecidium acanthacearum Cooke, rust.
Aecidium justiciae P. Henn., rust.

MIMULOPSIS sp. (Indigenous).
Irenina irregularis Stevens, on leaves.
Meliola psychotriae Earle, on leaves.

THUNBERGIA ALATA (Indigenous).
Puccinia thunbergiae-alatae P. Henn., rust.

WHITFIELDIA sp. (Indigenous).
Schiffnerula sp., on leaves.

HOST indet.
Asterina tertia Rac., var. *africana* Doidge.

VERBENACEAE.

CLERODENDRON sp. (Indigenous).
Meliola clerodendricola P. Henn., on leaves.
Meliola clerodendri Hansford, on leaves.
Meliola sakawensis, var. *acutiseta* Hansford.
Wageria sp., on leaves.
Euryachora sp., on leaves.
Asterina clerodendricola Hansford, on leaves.
Hemileia scholzii (P. Henn.) Syd., rust.
Uredo convestita Syd., rust.
Aecidium sp.. rust.

LANTANA sp. (Indigenous).
Meliola sakawensis P. Henn., on leaves.
Puccinia natalensis Diet. & Syd., rust.
Cladosporium herbarum Lk., var.. produces dull white to greenish-brown spots on the leaves.

LIPPIA sp. (Indigenous).
Puccinia accedens Syd., rust.
Puccinia lippivora Syd., rust.

VERBENA sp. (Cultivated).
Helminthosporium sp., leaf spot.

VITEX sp. (Indigenous).
Olivea petitiae Arth., rust.

LABIATAE.

COLEUS sp. (Indigenous).
Irene inermis (Kalch. & Cke.) Th. and Syd., var. *minor* Hansford & Stevens, on leaves.
Irenina glabra (B. & C.) Stev., on leaves.
Meliola psychotriae Earle, on leaves.

GENIOSPORUM PALUDOSUM (Indigenous).
Aecidium geniosporii Wakef. & Hansf., rust.
Englerulaster geniosporii Hansford, on leaves.

HOSLUNDIA sp. (Indigenous).
Meliola microspora Pat. & Gaill., on leaves and young stems.
Eutypella sp., on dying stems.
Puccinia hoslundiae Grove, rust.

HYPTIS SPICATA (Indigenous).
Irene inermis, var. *minor* Hansford and Stevens, on leaves.
Uredo sp., rust (? *Puccinia hyptidis*).

LEONOTIS sp. (Indigenous).
Oidium sp., mildew.
Puccinia leonotidicola P. Henn., rust.
Phoma sp., on stem.

LEUCAS sp. (Indigenous).
Puccinia leucadis Syd., rust.

MENTHA AQUATICA (Indigenous).
Puccinia menthae Pers., rust.

MICROMERIA sp. (Indigenous).
Uredo sp., rust.

OCIMUM BASILICUM (Sweet Basil).
Peronospora lamii A. Br., downy mildew, causing severe defoliation and wholesale death of plants at Kampala; on account of this disease the cultivation of the host for extraction of essential oil was abandoned.

OCIMUM sp. (Indigenous).
Uromyces ocimi Hansford, rust of *O. menthaefolium*.
Puccinia ocimi Doidge, rust of *O. suave* and *O. trichodon*.
Meliola psychotriae Earle, on leaves.

POGOSTEMON CABLIN (Patchouli).
Pythium sp., causing rotting of cuttings and of older plants in field.

PYCNOSTACHYS DAWEI (Indigenous).
Aecidium pycnostachydis Kalch., rust.

HOST indet.
Irene inermis var. *minor* Hansford and Stevens, on leaves.

(To be continued)